THURSDAY, FEBRUARY 25, 1909.

THE NATURAL HISTORY OF CONDUCT.

The Origin and Development of the Moral Ideas. By E. Westermarck. In 2 vols. Vol. ii. Pp. xv+852. (London: Macmillan and Co., Ltd., 1908.) Price 14*s*. net.

THE present volume completes Prof. Westermarck's work, which is likely to remain for a long time a standard repertory of facts, which the moralists of every school will, no doubt, set themselves to interpret, each after his own fashion. *Hic liber est in quo quaeret sua dogmata quisque,* and it is as a tribute to the author's erudition and fulness of matter that I hasten to add that the second half of the distich is also likely to be fulfilled; there are few schools of moralists who will not find something to their taste in this vast repertory of information about the moral codes and practices of mankind. The practices and beliefs of different races and ages with respect to the rights and duties of property, regard for the truth, concern for the general happiness, suicide, sexual relations, religion, and the supernatural generally, such are only a few of the topics with which Prof. Westermarck deals, and he deals with none of them without producing masses of significant fact for which, apart from his aid, the student of moral ideas and institutions would have to search hopelessly through the whole literature of anthropology. Merely to have done so much, even if Prof. Westermarck had gone no further, would have been to establish an inextinguishable claim on the gratitude of his readers, but it need not be said of the author of the "History of Human Marriage" that he has attempted to do much more. His aim, at least, is not merely to record the facts and classify them, but to offer a philosophical interpretation of them, to put forward a definite theory of the "origin" and "development" of the ethical side of human thought. It is quite out of the question for a single reviewer, who is not even an anthropologist, to presume to pronounce a summary judgment upon the success with which the task has been executed, and the present writer would therefore be understood to be attempting nothing more than the utterance of one or two of the reflections suggested to one interested reader by Prof. Westermarck's book.

In one respect, the work before us, even if attention were confined to the present volume alone, is less fortunate than the book by which the author made his great reputation as an anthropologist years ago. The "History of Human Marriage" was not merely a great collection of interesting facts; it had a very definite thesis, which was kept in view from the very first, and of which the reader was never allowed to lose sight for long, and that thesis had the further attraction of being, in the then state of anthropological speculation, a novel one. The present work has also, of course, its thesis, but it is one which is, for the greater part of the time, obscured by the very masses of detailed fact which are marshalled in support of it. Perhaps there never was a book in which it was harder to see the wood for the trees, or from which it would be easier to carve out whole monographs on connected groups of moral practices which seem to have no special bearing on the author's or any other man's theory of the fundamental character of moral action and the moral judgment. The main thesis, when one reaches it, is, perhaps, also a little disappointing. In essentials, it seems to contain nothing which is not already familiar to the student of so old-established a moralist as Hume, except, perhaps, the employment of the expression "altruistic" sentiment, in the sense of pleasure or pain awakened by our consciousness of the pleasure or pain of others, and this, again, is familiar to us from Comtism. Briefly put, the author's position is that the moral concepts (good, bad, right, wrong, and the rest) are based on "moral emotions," and that *moral* emotions (the sense of approval and censure) are retributive in character, censure being akin to revenge, approval to gratitude. These emotions themselves are things which "have been acquired by means of natural selection in the struggle for existence." A censorious critic would probably remark that, so far as regards the "origin" of the moral judgment, this theory leaves us just where it found us. "Natural selection," even if we allow it all the significance which has been claimed for it by the ultra-Darwinians, can, at best, account for the preservation of a favourable variation when it presents itself. Prof. Westermarck almost seems to invoke it to account for the variations it preserves. It is more to my purpose, however, to urge that the reduction of all moral judgments to the expression of "retributive" emotion seems only possible if we confine morality to the class of acts which are directly approved or blamed on account of their effect on some being other than the agent. If we do this, we are led at once into a breach with unsophisticated moral opinion. *E.g.* such opinion would pronounce it absurd to hold that a prudential regard for one's own future, a devotion to one's own physical and mental improvement, are not valuable moral qualities.

I note that Prof. Westermarck seems at times inclined to admit these, and even more startling, paradoxes. He habitually distinguishes between "prudential" and moral considerations, as if the same set of reasons for choosing a line of conduct might not fall under both heads at once, and, in one place, he even seems to suggest that we have no right to condemn two adults who choose to commit sodomy, on the ground that their behaviour hurts no one but themselves. (At least, he writes sympathetically of this doctrine, p. 483.) The example suggests a further criticism on the author's general philosophical standpoint. As it sufficiently shows, he really leaves no place in his system for a reasoned desire to promote the good of others, as distinct from an amiable tendency to enjoy witnessing their pleasure. Now it seems undeniable that the actual production of pleasure in others is only a very subordinate element in the kind of good which persons of ardent philanthropic zeal, without any preconceived theory of ethics, believe it their duty to promote. Just as I am conscious that pleasure, as such, is only a minor element in the good I desire for myself, so I am conscious that it is only a minor element in the good I believe it my duty, say, as a father to promote for my child; and, as I say, I believe this conviction to be shared by the generality of high-minded men who are not pre-committed to any particular scheme of moral philosophy.

It may, no doubt, be said that the view is a mistaken one, but at least it is there, and it is a serious defect in a proposed analysis of actual morality that it leaves no way of accounting for the fact. Where Prof. Westermarck, if I may say so without presumption, goes wrong is in directing his attention primarily to the kinds of emotion which accompany moral judgments instead of attempting to study just the general character of the conduct upon which the judgments are passed. As Mr. Bradley put it long ago, with reference to J. S. Mill's account of poetry, "Anything in the way of shallow reflection on the psychological form rather than an attempt to grasp the content." It is the same undue preoccupation with psychological form as opposed to ethical content, as it seems to me, which makes Prof. Westermarck's attempts to trace and forecast the development of moral belief and practice disappointing. He has little that is suggestive to say about the actual development of the moral ideal within the history of civilisation; indeed, about the oldest and perhaps the most influential of still existing moral institutions, the Christian Church, he always writes with a lack of appreciation which might fairly have been blamed in an eighteenth-century *illuminé*, though one would have expected that, in its Catholic form, it would have appealed to him in virtue of its "cosmopolitanism." The chief prophecy he makes as to the future is that "the altruistic sentiment will continue to expand." Whether this is a prophecy of good I am not sure. No doubt it is, if it means that devotion to a common good is to become a more prominent factor in all our action. If it means that devotion to definite organisations for social life is to be replaced by aimless amiability towards the human race in general, there may be reason to doubt whether the substitution would be in the direction of genuine progress.

A. E. TAYLOR.

POPULAR ELECTRICITY.

Electricity Present and Future. By Lucien Poincaré. Translated by Jasper Kemmis. Pp. viii+315. (London: Sisley's, Ltd., n.d.) Price 7*s*. 6*d*. net.

THE title of this book is certainly a misnomer, and any reader expecting therefrom to find the volume largely occupied with a prophecy of the future development of electricity is destined to be disappointed. Had the book been called "Electricity Past and Present," the subject-matter would have been much more correctly indicated, as a fair amount of historical matter is combined with the description of the present state of applied electricity. Regarded simply as a popular exposition of this state, the work has much to recommend it, but it is, perhaps, hardly fair to the author's intentions to look on it simply in this light. From the preface one gathers that the intention has been to trace the tendencies observable in recent developments in electrical engineering, and to produce a work, to use the author's own words, "not unworthy a place in a collection of studies in scientific philosophy." Candidly, we must admit that we are not impressed with the "scientific philosophy" of the book, unless, indeed, it is philosophy to show how the simpler forms of machines and apparatus have been modified to suit the varied requirements of modern industry.

The first part of the book is occupied with theoretical matters, the main outlines of the theory of magnetism and of induction being clearly expounded. Then follow two chapters on generating machines and motors, a fairly long chapter on the transmission of energy, and finally two short chapters on electro-chemistry and electric lighting. These chapters form the main portion of the book; they are clearly written, and give a clear and interesting account of the subjects with which they deal. We cannot help thinking that the addition of a few simple diagrams and illustrations would greatly assist the explanations of some of the more complicated points; the reader whose knowledge of electrical technology is not very extensive is likely to find some of the passages difficult to follow. Indeed, we think the whole book, excellent though it is in many respects, would be greatly improved by simplification and a frank abandonment of the philosophic aims which have helped to inspire it, and which have given rise, we think, to such defects as it possesses. Amongst such defects may be noted certain peculiarities of style which are apparently attempts to give the book a literary value, but which, in our opinion, have just the reverse effect. To quote one or two examples, we read, on p. 38, "M. Warburg justly claims the distinction of having been the first, in 1880 . . ." when we suppose all that is meant is that M. Warburg *has* the distinction, &c. On the same page a sentence referring to Ewing's work on hysteresis is immediately followed by a paragraph opening, "This same Ewing studied in all their complex details these phenomena." Why not say Ewing studied these phenomena in all their complex details? Instances could be multiplied almost indefinitely, but we will content ourselves with one other quotation. On p. 27 we read:—

"However, notwithstanding the high respect entertained for the ventures of this great scientist (*Faraday*), whose experiments were the most original and productive that science had seen in the nineteenth century, and notwithstanding the lucidity of his 'Experimental Researches in Electricity,' one cannot but feel surprised, even shocked, at the methods he employed in describing matters which are not in consonance with the conventional forms of mathematical symbols."

We are not quite sure what is the meaning, if any, of the last sentence, and whether it is the "methods" or the "matters" which offend; but assuredly the criticism is most unjust, and the author (or is it the translator?) could not do better than study that simplicity of language which enabled Faraday to confer such "lucidity" on his writings. After all, M. Poincaré is attempting a similar task in this book in endeavouring to present the position of electrical theory and practice by methods "not in consonance with the conventional forms of mathematical symbols."

There is one matter to which we feel we must refer in conclusion, though it does not affect the general merits of the book. Surely never was an index more curiously compiled since someone wrote, "Mill, on Liberty: do., on the Floss" in a book catalogue. What can be said of such entries as these? "Both fields interdependent," as a reference to the interdependence of the electric and magnetic fields; "First Consul's opinion"; "Electricity, mystery of, 4; physicists cannot explain, 5; contingencies increase, 6; reason obvious, 7"; "Whence mechanical work?" If the rest of the index were comprehensive and well-arranged, such peculiarities might be excused as, possibly, intentionally humorous; but unfortunately such is not the case. Thus arc lamps are indexed under "Lamps, arc," but incandescent lamps under "Incandescent," and there are no cross-references. Also, in the preface a full list of the names referred to in the book is promised in the index, but the majority are not to be found there.

MAURICE SOLOMON.

THE CAUSES OF MUTATION.

Mutation et Traumatismes, Etude sur l'Evolution des Formes végétales. By L. Blaringhem. Pp. 239; 8 plates. (Paris: Félix Alcan, 1908.) Price 10 francs.

ACCORDING to the mutational view of evolution, the kind of variations to the survival of which specific differentiation is due are not such differences between individuals as are always afforded, in any large collection, by fluctuating variability; but variations of an entirely different nature, which de Vries has called mutations. These mutations are not, as repeatedly stated, larger differences than those which are due to fluctuating variability. On the contrary, the differences between the extreme variants of fluctuating variations are often so large that they cannot escape the notice of the most unobservant; whereas the difference between the new types (especially when these are elementary species, and not varieties) which arise by mutation are often so subtle that they can often only be detected by an observer with an intimate familiarity with the species in question.

The great difference, according to de Vries, between these two types of variation is that the maintenance of any new stage which has been reached by the selection of the extreme variants of fluctuating variability is dependent on the continuation of the selection which produced it, whereas the new types which arise by mutation are independent of selection. Of course, if the new types are sickly or are characterised by the acquisition of new characters which interfere with their attainment of maturity they very soon cease to exist. The point is that the origin of the new type on the latter view is independent of selection, whilst on the former it is due to it; and this holds good for the origin of new types in a state of domestication as well as in wild nature. The new form "is seen to be very good after, not before its creation."

But perhaps the most striking difference between the two kinds of variation is that fluctuating variability is exhibited by all animals and plants at all times, whereas mutability appears to be exhibited only very rarely. Indeed, de Vries only found one plant which appeared to be in this state (Œnothera), although he tested a large variety of plants for the purpose. Now, if it is true that evolution is due to the differences presented by mutability, we naturally want to know to what these mutable phases are due; and it is a paradoxical fact that de Vries should have discovered a great deal about the causes of fluctuating variability and next to nothing about those of mutability. A great many of the differences which are classed as fluctuating can be attributed with great certainty to differences of nutrition, and there is a long series of facts (in connection with the limit attainable by the selection of such variations) which go to support this explanation.

Of the causes of mutation little is certainly known, though it is generally held that the inception of a mutable phase is caused by some disturbance of that equilibrium in the germ-plasm which expresses itself in the stability of a species which is not in a mutable state. Indeed, the generality of a belief in that form of variation which has since been called mutation, and of this view, as to the cause of it, is witnessed by the existence of a special French word, "affoler," to express the process by which this disturbance of the equilibrium may be effected. The term "affolement" is also used by gardeners to signify the state which this brings about, in other words, the mutable phase itself. The book before us is an account of a long series of experiments which M. Blaringhem has conducted on the effect of mutilations on the maize and other plants. He finds that the buds which are produced after such mutilation (such as severing the stem) bear a far larger number of abnormal organs —stems, leaves, flowers, and fruits—than do normal unmolested plants; and, moreover, that amongst the offspring of mutilated plants there occur (1) considerable monstrosities; (2) plants which have recovered the ancestral equilibrium; and (3) very occasional slight anomalies which constitute varieties and are perfectly new and constant.

M. Blaringhem has come in touch with the outskirts of an extremely interesting problem, namely, the effect of the rate, at which vital processes take place, on their normality. It may be that the luxuriance of life in the tropics is due to the speed at which ontogenetic processes take place there; if heat increases the rate at which growth takes place (as it is known to), and increased speed leads to increased variability, the luxuriance of tropical life may be simply due to wide range of variations placed at the disposal of natural selection to operate upon. Similarly the enormous speed at which growth proceeds in buds produced on plants which have been cut down to the ground may be the sole cause of the increase in the number of monstrosities produced by them. Here is matter for investigation, the results of which ought to be of the greatest interest and value. M. Blaringhem's account of his experiments forms a stimulating starting-point to such an inquiry, and should be read by everyone engaged in the experimental study of vital processes.

THE SUBJECT-MATTER OF ANTHROPOLOGY.

The Scope and Content of the Science of Anthropology. By Juul Dieserud. Pp. 200. (Chicago: The Open Court Publishing Co.; London: Kegan Paul, Trench, Trübner and Co., Ltd., 1908.) Price 8*s*. 6*d*. net.

A PERUSAL of this book will convince most people that the terminology and classification of the subject-matter of anthropology is at present in a state of almost hopeless confusion. In England, early authorities like Hunt defined anthropology as the science of the whole nature of man, including the study of his anatomical, physiological and psychological characters, and this logical view has fortunately been maintained among the majority of anthropologists in this country up to the present day. In France also the original view, as expressed by Pruner Bey, was that anthropology embraces the study of man in time and space, and the great Broca took a very similar view of the scope of the science. In Germany, however, a beginning of the descent from this clear and reasonable definition of the science appears to have been made in 1879 by Müller, who divided anthropology into (1) physical anthropology and (2) psychic anthropology, and this cleavage was made wider by Grosse, who in 1894 completely separated the second of Müller's subdivisions from anthropology and gave it a new designation, namely, ethnology, or the culture of races.

Ethnology and its related term ethnography were henceforth widely applied, chiefly in Germany and America, to a new science dealing with the culture of races. It was excluded from the science of anthropology, chiefly, no doubt, because this study had increased more rapidly than other departments of anthropology, its material data being represented by large collections of tools, weapons, dress and pottery in museums, and its psychic data by numerous memoirs on manners and customs, religion and folklore. From a logical point of view it is difficult to see why the study of the psychological evolution of man, as expressed by the various products of his activity, should be excluded from anthropology—the science of the whole nature of man—and it is still more difficult to see why the term ethnology, which etymologically means the science of peoples or races, should be applied to this new science, for which the proper designation would appear to be that given to it by Achelis, namely, psychical anthropology.

This confusion in the terminology of anthropology is, however, now so widespread that it will take a long time to set it right, and Mr. Dieserud's book will, we fear, only tend to perpetuate the confusion. He shows himself throughout strongly in favour of the misuse of the term ethnology by excluding from its scope all somatic or physical anthropology, though he very illogically compromises between reason and use, or rather abuse, by admitting physical subject-matter under the allied term ethnography.

The second part of Mr. Dieserud's book consists of a scheme of library classification for works on anthropology. He divides the subject into three main classes, namely, (1) general, (2) somatology or physical anthropology, and (3) ethnical anthropology. The second and third classes are further subdivided, and a comparison of some of these subdivisions will give some idea of the consequences of the irrational classification of anthropology which the author has adopted. For example, under class (2) we have a subdivision "racial psychology," and under class (3) a subdivision "ethnical or folk-psychology." The plain man will find it very difficult from the names to discover any difference between the two subclasses. There appears to be a great amount of apparent overlapping in other subclasses; for example, it is difficult to distinguish between palæoanthropology and palæoethnology or archæology, and yet these are separate and distinct subdivisions.

In the details of the physical anthropology section of his classification, the author evidently owes a great deal to the excellent scheme of Prof. Martin, of Zürich, and where he departs from this it is not often by way of improvement.

The subdivision of his third class, "ethnical anthropology (or psycho-socio-cultural anthropology)," is very minute, but apparently here also we have redundancy; for example, "gambling and its implements" and "gambling implements" are two different subdivisions, one of which appears to be unnecessary.

Part iii. of this work consists of a bibliography containing a list of a few important works on anthropology, with notes of their contents, and a list of the chief publications of leading anthropological societies and museums.

Though we cannot recommend Mr. Dieserud's scheme of classification either to librarians or anthropologists, his book is well worth reading, and contains much material that is of great value to the anthropologist who is interested in the question of the scope and content of his science.

J. G.

REFRIGERATION.

The Mechanical Production of Cold. By J. A. Ewing. Pp. x+204; illustrated. (Cambridge: University Press, 1908.) Price 10*s*.

LOW temperatures are rapidly becoming of great industrial and scientific importance, so that the general principles of their application are necessary or useful to continually increasing numbers of people. In this book Prof. Ewing has brought the Howard lectures, which he gave to the Society of Arts in 1897, up to date in various directions by the addition of sections on the more important developments in the last ten years. In these attention is paid to such questions as the production of oxygen by the rectification of liquid air and the theoretical investigations which lead to the calculation of the efficiency of refrigerating engines.

Starting with the conception of a refrigerating engine as a heat pump which requires the expenditure of mechanical energy to bring heat from a lower to a higher level of temperature working on a reversed Carnot's cycle, the significance of indicator and entropy diagrams is explained in non-mathematical language. The thermodynamical details are worked out more completely in various appendices. These include discussions of entropy (ϕ) diagrams, with either temperature or thermodynamic potential (i) as the other coordinate. A reproduction on a large scale of Dr. R. Mollier's ϕ-i diagram for carbon dioxide is given at the end of the book, and its usefulness in tracing the exact behaviour of an engine using this as working substance is shown. There are also tables of the properties of ammonia, sulphur dioxide, carbon dioxide, and water vapour which would be necessary in such calculations. All these data are given in C.G.S. units, and it is to be regretted that these have not been used throughout the book so as to make it more uniform, and also because there is a strong opinion now that either C.G.S. or some derived units founded on them would be used internationally in applied thermodynamics with the same advantage as they have been in applied electricity.

Absorption and air-compression machines are now only employed in special cases, but they are interesting, and are considered in the second and third chapters.

At the present time, nearly all new installations use the vapour-compression system to which the fourth chapter is devoted. The substances which are used are water vapour, which is clearly only applicable in very special cases, carbon dioxide, sulphur dioxide, ammonia, and methyl chloride. Each of these has special applications, determined by size or danger of explosion, or the unwholesome nature of the gas, in addition to their efficiencies as working substances. It is shown that the theoretical efficiencies increase in the order given with the exception of the last, which is only just mentioned, although it is employed in well-known cascade installations, and is coming into use largely as a convenient substance for small portable machines on rail-road cars and similar places. This chapter, in connection with the following sections devoted to the testing of refrigerating machines, especially by the Munich method, should be of considerable use to students and other workers in this field. Short accounts follow of the principal applications of moderate cold in industries such as brewing and others depending on fermentation processes, also in ice-making, and in the preservation and transport of food and other perishable articles. A section is devoted to the cooling of magazines in ships of war, about which the author writes with special authority.

The remainder of the book discusses the production and application of very low temperatures, such as those obtained by liquid air, liquid hydrogen, and now quite recently by liquid helium. There are three principal methods of reaching these low temperatures, which are all described: the cascade of Cailletet and Pictet, the expansion method of Siemens and others, and the combination of the cooling due to throttling and the regenerative principle by Linde. The main industrial application is for the production of oxygen from liquid air, which is obtained by the Linde process or by the modification of this introduced by Claude, in which the Siemens principle is combined with it. There are considered in detail, and it is shown how the rectification is carried out so that nearly pure nitrogen, as well as nearly pure oxygen, is obtained by the same process. Dewar's work on hydrogen follows, with a *résumé* of its properties and a mention of those of liquid helium.

The book is well illustrated with diagrams and drawings, and has a good index. F. H.

OUR BOOK SHELF.

Principles and Methods of Physical Education and Hygiene. By W. P. Welpton. Pp. xix+401. (Cambridge: University Tutorial Press, Ltd., 1908.) Price 4*s*. 6*d*.

THIS book is addressed to the teachers of elementary schools, and to such of them as enjoy the study of physiology much pleasure will be derived from the perusal of every chapter. The author, we see, is master of method in the University of Leeds; he describes methods as well as theory of cleanliness, ventilation, care of the eye, and such "first aid" as is likely to be called for. More theory than method, however, is set down to advance the practising of the physical exercise part of physical education. We have no idea how the author would arrange to get the best use out of the school playground; how he would attain some organisation of games among scholars without encroaching upon the teacher's time.

"Glycogen" is referred to seven times in the index, but one can find no list of games or activities that suit the different periods of school life, such as would be helpful to the organiser of physical education; accordingly one regrets that theory dominates this work. We are apt to forget that our professional trainers of athletes have been very successful in their way, and with them athletics called the trainers into being; a development of play is the first step towards bettering physical education.

Everyone interested either in games or physical education in its fuller aspect will be delighted with the chapter on the history of physical education, contributed by Prof. J. Welton, with quotations such as that from Lucian on the Athenian boy. "When he has laboured diligently at intellectual studies and his mind is sated with the benefits of the school curriculum, he exercises his body in liberal pursuits, riding or hurling the javelin or spear. Then the wrestling school with its sleek oiled pupils labours under the midday sun, and sweats in the regular athletic contests. Then a bath, not too prolonged; then a meal, not too large, in view of afternoon school. For the schoolmasters are waiting for him again, and the books which openly or by allegory teach him who was a great hero, who was a lover of justice and purity. With the contemplation of such virtues he waters the garden of his young soul. When evening sets a limit to his work, he pays the necessary tribute to his stomach and retires to rest to sleep sweetly after his busy day." Education in this breadth and spirit, lost in the dark ages—for the exercises of chivalry do not represent it—was revived in Italy at the Renaissance, and the first English exponents of this revival—Mulcaster, 1581, and Sir Thos. Elyot, 1531—had their influence dominated by the Puritanism of those and later times. Perhaps the latter spirit is still effective, as cricket is apparently never played on Sunday.

The neglect of physical education up to the time of Rousseau is sketched by Prof. Welton, and its advance since then in secondary schools. He tells us with regard to elementary schools that the conception of education that guided the Education Act of 1870 was essentially the scholastic tradition, that education and instruction are synonymous, and he affirms the most crying need in English education of to-day to be adequate provision for physical training. H. R. B.

Bathy-orographical Map of the British Isles. Natural Scale 1 : 875,300, or 14 miles to an inch. *Bathy-orographical Map of South America.* Natural Scale 1 : 6,150,000, or 97 miles to an inch. Constructed and engraved by W. and A. K. Johnston, Ltd. Prices not stated.

Handbook to accompany the Map of the British Isles. Pp. 32. Price 6*d*. net.

No more convincing indication could be found of the improvement which has taken place in recent years in the methods of geographical instruction in schools than the enterprise shown by publishers in the production of good orographical maps, both in atlases and on a large scale for class-teaching purposes. The present wall-maps are good examples of the excellent aids which are available to assist teachers in demonstrating the fundamental importance of the distribution of the highlands and lowlands of the areas being studied. In the map of the British Isles six shades of brown are employed to show graphically the course of important contours on the land, and two shades of blue indicate the 20- and 50-fathom lines in the surrounding seas. In the case of South America the varying heights of the land above sea level are depicted by five shades of brown and two of green, while the 100-, 1000-, and 2000-fathom lines are shown on the oceans. Care has been taken to avoid crowding, and the maps are models of clearness.

The "Handbook" should prove a great help to those teachers of geography who have had little experience in teaching their subject by modern practical methods.

Invariants of Quadratic Differential Forms. By J. E. Wright. Pp. vi+90. Cambridge Tracts in Mathematics and Mathematical Physics, No. 9. (Cambridge: University Press, 1908.) Price 2*s*. 6*d*. net.

THIS number of the Cambridge Tracts deals with a clear and definite problem, the simplest case of which may be stated as follows. Let *a, b, c* be given functions of the independent variables, *x, y*, and let

$$adx^2 + bdxdy + cdy^2$$

become

$$\alpha d\xi^2 + \beta\gamma d\xi d\eta + d\eta^2$$

by a change of variables from (x, y) to (ξ, η); what functions of *a, b, c* and their differential coefficients transform into the same functions of α, β, γ and their differential coefficients? The importance of this inquiry begins to appear in Gauss's celebrated memoir on the deformation of surfaces; and a very large part of what is called the differential geometry of surfaces is, from another point of view, the invariant theory of a quadratic differential form in two variables. In the general theory there are *n* variables, and the first great step in this direction was taken by Riemann; references to his principal successors are given by Prof. Wright (pp. 5–8). The methods explained in the tract are those of Christoffel, Lie, and Maschke; the last, which is symbolical, and quite recent, is only very briefly summarised, but enough is done to show its interesting character. Another special calculus applied to the subject is that of Levi-Cività and Ricci (pp. 20–8); and other manipulative devices may doubtless be discovered. So far as one can see at present, the essential elements of the theory are the Riemann-Christoffel four-figure symbols; while the broadest aspect of it is presented by Lie.

Pp. 51–90 give various geometrical and dynamical applications, concluding with the representation of one manifold on another with correspondence of geodesics. Besides being a useful guide to the analytical theory, this tract will be of service to readers of Darboux's and Bianchi's works on the theory of surfaces.

G. B. M.

A Course of Plane Geometry for Advanced Students. Part I. By C. V. Durell. Pp. xi+219. (London: Macmillan and Co., Ltd., 1909.) Price 5*s*. net.

THIS is a really capital book for students of what may be called scholarship standard. It contains, among other things, sections on similarity, transversals, vector geometry, inversion, and coaxal circles. As examples of the author's choice of elegant methods, and his clearness of exposition, may be taken the proof (due to Mr. Hillyer) that the centres of the diagonals of a complete quadrilateral are collinear (p. 118), and the proof of Feuerbach's theorem by inversion (p. 149). In the latter example, as in many others, teachers will notice the excellence of the diagrams, which give, without confusion, all that is required and no more. There is a practically inexhaustible stock of examples, with a very wide range of difficulty. Mr. Durell is a master at Winchester College, and those who remember the late Mr. Richardson's success in making his boys like and learn geometry will be glad to see that there is no risk of the subject being neglected now that he is gone.

The Contents of the Fifth and Sixth Books of Euclid. By M. J. M. Hill. Second edition. Pp. xx+167. (Cambridge: University Press, 1908.) Price 6*s*. net.

THIS is a new work rather than a new edition. Prof. Hill has now completely abandoned Euclid's treatment of proportion as given in his fifth and sixth books, and replaced it by an arithmetical theory. Two commensurable quantities, pA, qA, are *defined* as having the ratio p/q. Equal ratios are *defined* as those between which no rational fraction lies. The theory is now made rigorous by means of Dedekind's treatment of irrational numbers, the Cantor-Dedekind axiom, and the axiom of Archimedes. It is a foolish man that never changes his mind; and Prof. Hill's deliberate change of method after eight more years of teaching is a fact to which special attention should be directed.

The Elementary Dynamics of Solids and Fluids. By Prof. W. Peddie. With Sectional and General Examples by J. D. Fulton. Pp. xii+188. (Edinburgh and London: Oliver and Boyd, 1909.) Price 2*s*. 6*d*.

THIS little book is intended for use by junior students in university classes, and for boys in the higher forms of secondary schools. The treatment is very elementary, and fluids are disposed of in the concluding three of the thirteen chapters. The wisdom of printing answers immediately after the exercises throughout the book may be doubted. As an introduction to dynamics, the book should prove useful.

LETTERS TO THE EDITOR.

[*The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts intended for this or any other part of* NATURE. *No notice is taken of anonymous communications.*]

The Brilliancy and Intensity of the Cupric Chloride Flame Spectrum.

IN the account of an interesting investigation of the flame spectrum of cupric chloride communicated by Peter Kien (*Zeits. f. wissensch. Photographie*, 1908, vol. vi., 337) there occurs a sentence to the following effect:—

"How difficult it is to decide upon the brilliancy and intensity of a spectrum by means of photography may be shown by the following example:—

"Prof. Hartley has published a very beautiful small photograph of the cupric chloride spectrum, the only one, moreover, which up to the present has been published. It is not in the least over-exposed, notwithstanding that Hartley gave it an exposure of two hours. My photographs were over-exposed in ten minutes—even if, as Hartley did, I brought cupric oxide into the oxygen and coal-gas flame saturated with chloroform vapour."

I think it is due to the author and others to point out that he writes under a misapprehension, inasmuch as his spectra and mine were taken each in a different manner and with a different object in view. He desired to photograph the best spectrum obtainable from the chloride for the purpose of measuring the bands, and therefore burnt the usual rolls ("cigarettes") of filter paper containing either cupric chloride or the oxide. The "cigarettes" were pushed by a spring through a tube into the flame at a speed regulated by a clock-work arrangement.

When communicating a paper on some devices facilitating the study of spectra (Sci. Proc. Roy. Dublin Soc., vol. xi., p. 237, 1907), I demonstrated the extreme delicacy of the cupric chloride reaction in explanation of the reason that, although there may be no green coloration of the flame by copper, nevertheless the blue flame and cupric chloride bands are seen when salt is thrown into a fire of glowing coals.

The experiment was made in the following manner:—a quartz fibre about a millimetre thick was placed in a solution of a copper salt and heated in the flame of the Meker (or Mecke) burner supplied with coal-gas, which was burnt with a blast of air at a pressure of about 700 mm. of mercury. The fibre was heated until all the copper salt had been decomposed, as shown by scarcely any evidence of a trace of copper being visible in the flame when looked at in a darkened room. On diverting about one-third of the coal-gas through the flask containing sponge soaked in chloroform, the hydrochloric acid produced by the combustion of its vapour yielded a large and brilliant blue flame due to the cupric chloride, which was steady and continuous for a long period. For the illustration of the text of the paper the first exposure of the copper oxide was limited to two hours, then, without removing the fibre from the flame, the chloroform tap was turned on, and a similar exposure made.

An excess of hydrochloric acid prevents the spectrum being visible at all, so that with the large volume of nitrogen in the air, and the consequent reduction of temperature arising from the hydrochloric acid in the coal-gas flame, the proportion of chloroform vapour must be limited, and the resulting quantity of cupric chloride vaporised is correspondingly small.

In the experiments made by Kien, the greater intensity of photographic action is caused by the use of oxygen under pressure along with coal-gas, whereby, in consequence of the much higher temperature and greater quantity of heat, he is able to feed the flame with a much larger proportion of chloroform vapour, and consequently to volatilise a very much larger quantity of cupric chloride in the same period of time than is possible with the air blast. Furthermore, by the use of the "cigarette," he has a larger quantity of copper in the flame at any given moment.

As a rule, my flame spectra are obtained by using the oxy-hydrogen blow-pipe, and when the hydrogen is mixed with chloroform the photographic period of exposure, according to circumstances, varies from thirty seconds to five minutes.

That salt is decomposed and hydrochloric acid formed by the action of water vapour when salt is thrown into a coal fire is certain. It is proved by the fact, which I found out when studying this spectrum in 1887, that the characteristic blue flame is not obtainable when salt is thrown into a fire of charcoal. In 1890 Salet proved the origin of the blue flame to be cupric chloride (*Comptes rendus*, cx., p. 282), and not in any way connected, as had been suggested, with the spectrum of carbon, carbon monoxide, or hydrocarbon flames, nor due to the element chlorine or to hydrochloric acid. My interest in the matter thus came temporarily to an abrupt termination, because, having by this time become aware that minute quantities of copper are to be found in most metalliferous and many other minerals, also in acids, it was easy to account for the blue flame being frequently seen by reason of the extraordinary delicacy of the cupric chloride flame reaction. Coal ashes always contain copper, the origin of which is commonly pyrites, and in the fire this is speedily burnt to oxide. Sulphur dioxide, steam, and air, even below a very dull red heat, convert salt into sodium sulphate and hydrochloric acid, and hence the formation of cupric chloride in presence of an excess of hydrochloric acid. Kien's paper gives an admirable historical account of the subject, which is particularly interesting owing to the extraordinarily illusive and elusive character of this spectrum. Much of this may be read in the *Phil. Mag.* (4), vol. xxiv., 417–9, and the pages of NATURE during 1876 and 1879.

A very beautiful engraving of the cupric chloride bands is given in Lecoq de Boisbaudran's "Spectres lumineux," published in 1874.

W. N. HARTLEY.

Royal College of Science, Dublin, February 11.

On the Radio-active Deposits from Actinium.

IN the course of some experiments which Mr. W. T. Kennedy has been making at Toronto during the past few months, he has found a marked similarity in the active deposits obtained on positively and negatively charged electrodes placed within an air-tight vessel and subjected to the influence of the active emanation issuing from a sample of actinium.

In his experiments the electrodes consisted of two small circular brass discs provided with guard rings of the same metal, and placed parallel to each other at a distance of 2 mm. apart. The discs during an exposure were placed with their planes vertical and directly over an open metal tube 1·5 mm. in diameter, with the edges of the guard rings almost in contact with the edges of the upper end of the tube. The salt used was carried in a small tray which could slide freely up and down the tube, and by means of a clamp be supported at any required distance from the discs.

In carrying out a set of experiments on the effect of varying the pressure of the air in the vessel containing the discs and the salt, it was found at high pressures that the active deposit appeared almost entirely on the negative electrode. As the pressure was decreased, however, the active deposits on both electrodes increased, and ultimately at certain definite pressures, which were different for the two electrodes, reached maximum values. When the pressures were still further lowered, the amounts of the deposit received on both electrodes rapidly decreased, and finally approached equality. Up to the present the lowest pressure used is $\frac{1}{2}$ mm. of mercury, and at this pressure the deposit on the negative electrode was found to be only about 3 per cent. greater than that obtained on the positive. From the rapid character of the decrease in the amounts of the deposit obtained at the lower pressures, it seems highly probable that, with the arrangement of apparatus used, and the relative distances between the parts adopted, both electrodes would fail to show any activity, or at greatest a very small one, if the air were entirely removed from the exposing vessel.

In a particular experiment with the salt at a distance of 1 cm. from the disc electrodes, a maximum activity was obtained on the negative electrode at a pressure of 6·5 cm. of mercury, while for the same distance between the salt and the electrodes the maximum deposit on the positive electrode was not obtained until a pressure of 1 cm. of mercury was reached. In this experiment the maximum activity obtained on the negative electrode was about 2·75 times the maximum activity obtained on the positive terminal. In all the experiments at the various pressures the discs were exposed for two hours to the action of the emanation from the actinium before being removed from the exposing vessel for measurement. The salt used was obtained from the Chinin Fabrik at Brunswick, Germany, and the active deposits on both the electrodes were found to have a decay period of approximately thirty-nine minutes.

The experiments as a whole point to the ions produced by the radiation from the active salt and its products in the gas in which the salt is placed as the carriers of the active deposit. They seem to indicate, moreover, that the known differences in the rates of diffusion of positive and negative gaseous ions will suffice to explain the differences obtained in the amounts of the active deposit on the two electrodes. J. C. McLENNAN.

Physical Laboratory, University of Toronto, February 6.

Germination of the Broad Bean Seed.

MR. HEBER SMITH's observations on the relation of the micropyle to the radicle in the seed of *Vicia faba* (NATURE, February 4, p. 400) are quite correct. It is surprising that the structure and germination of this seed, so extensively used in elementary botanical teaching, should be so frequently misunderstood by teachers and wrongly described in text-books. The curious minute structure of the coat of leguminous seeds has been thoroughly investigated by Haberlandt, Beck, Pammel, and others, but has never, to my knowledge, found mention in any student's text-book. There is, however, no excuse for the inaccurate statement, made in many an elementary work on botany and on nature-study, that the radicle always grows out through the micropyle when germination begins. Beyond admitting water into the seed, the micropyle, as a rule, merely forms a weak spot in the testa and enables the radicle to split the latter, while in leguminous seeds the splitting occurs quite independently of this aperture.

In the broad-bean seed, with its well-developed "radicle-pocket," the swelling radicle, aided by the elongating cotyledon-stalks, pushes out a V-shaped flap, the micropyle being (as Mr. Heber Smith states) left intact. The two "lines of weakness," which form the edge of the flap, answer to the junction of the radicle-pocket with the inner surface of the testa. The partition which constitutes the inner wall of the pocket can be seen in sections of young seeds as a ridge projecting into the seed cavity between the micropyle and the radicle.

In the seeds of French bean (*Phaseolus vulgaris*) and scarlet runners (*P. multiflorus*, &c.) the pocket is less highly developed, and at an early stage the coat splits transversely, starting from the tip of the radicle. As in the broad bean, the micropyle remains intact at the end of the hilum.

The early stages in the germination of broad bean are, I believe, accurately shown in my "Life-histories of Common Plants," Fig. 10. FRANK CAVERS.

Hartley University College, Southampton, February 13.

Scientific Societies and the Admission of Women Fellows.

NATURE of February 11 contains an able article on the Chemical Society and the admission of women fellows. Much of what is said in that article would apply equally well to the Geological Society.

On May 15, 1907, the council proposed a new bye-law for the admission of women as "associates." There is no authority in the charter for the admission of associates, whether women or men; and the proposition was rejected by a majority of two. The council having apparently dropped the subject, a special meeting was, on the requisition of certain fellows, held on April 1, 1908, when a resolution was proposed by Mr. E. A. Martin for the admission of women as fellows. This was defeated in favour of a motion by a member of the council that a poll be taken of all the fellows resident in the United Kingdom. The validity of such a poll having been questioned, the president (Prof. Sollas) admitted that there would be no validity in it, but said that, whatever the result might be, the council would loyally abide by it. The result of this poll was in favour of the admission of women as fellows. Subsequently, some non-resident fellows having objected to being excluded from voting, a further poll was taken of non-resident fellows, with a similar result. The votes recorded in the two polls were:—in favour of the admission of women, 439; against, 160. Of the 439, 318 were in favour of admitting women as fellows, 109 as "associates," while 12 expressed no preference. It is thus shown that there is a decided preference for the admission of women as fellows.

Notwithstanding these votes, and the statement that the council would abide by the result, the council has apparently done nothing to carry them into effect; but on February 10 a special meeting (convened by the council) was held to consider the result of the vote, but no intimation was given that any resolution would be proposed. The council put forward certain objections to the admission of women, and a motion by Dr. A. Smith Woodward, "That it is desirable, under the existing charter, to admit women to candidature for the fellowship of the society, on the same terms as men," was rejected by a majority of ten votes.

Whatever objections the council may have to the admission of women as fellows, it seems only reasonable that the fellows should have been informed before being called upon to express their wishes. By inviting them to vote, it was certainly implied that the decision of the fellows would be respected.

During the past twenty years there have been many able papers contributed by lady geologists, and the fellows have expressed a wish that women should now be admitted to the society on the same terms as men. By rejecting the wishes of the fellows, the council is acting, not only unjustly to lady geologists, but is ignoring the expression of opinion which the council itself invited.

Hythe, February 20. W. J. ATKINSON.

Stone Circles in Ireland.

IN his paper, "Who built the British Stone Circles?" read at the Dublin meeting of the British Association (NATURE, December 24, 1908, vol. lxxix., p. 236), Mr. J. Gray says he believes there are few, if any, such stone circles in Ireland. The accompanying photograph shows

Stone Circle, Culdaff, Co. Donegal.

one at Culdaff (river, bay, and village of the same name), on the north coast of County Donegal.

Only a few of the stones are now standing. Some have fallen down, others have been taken for building or other purposes; enough, however, still remain to show the form of the circle. Beyond it, on the eastern side, lie several blocks in two diverging rows. A short distance away there is a double-chambered structure of upright slabs, once covered by a mound, which, many years ago, was carted away and spread over the farm by a former tenant.

W. E. HART.

Kilderry, Londonderry, February 15.

ULTRA-MICROSCOPIC VISION.

IN NATURE, November 5, 1908, a short paragraph appeared in reference to a letter received from Mr. G. V. Raman, of the Science Association Laboratory, Calcutta, referring to a method of dark ground illumination for the microscope. From it, and from a subsequent communication on the same subject, it would appear that the subject of dark ground illumination and ultra-microscopic illumination may in certain directions give rise to controversy, and result in some confusion of thought.

It is unquestioned that any method of microscopic illumination in which the direct axial beam of light is cut out, and where, therefore, a grazing or oblique illumination is obtained, may result in making visible some particles that are beyond the limits of a microscope illuminated by ordinary methods.

It must at once be admitted that it is difficult to define the exact boundary beyond which objects may be said to be ultra-microscopic. To appreciate this point, it is necessary to refer very briefly—owing to the limits imposed in such a short article as this—to the wide difference between the limits of microscopic resolution and microscopic visibility.

To define the limits of resolution of the microscope is not difficult, as this is purely a function of the numerical aperture of the objective. The limits in this direction have been accurately determined, and practically agree in theory and practice. In the case of periodic structure, such as in diatoms, or in mechanically-ruled plates such as Grayson's rulings, this resolving limit can be found by multiplying the numerical aperture of the objective by 80,000 when monochromatic green light is used, and illumination is by a solid axial cone of light. This means approximately that lines of more than 120,000 to the inch would be beyond the limit of resolution when using an objective with N.A. 1·40, the largest aperture generally available at present; or that two points lying closer together than the distance between these would be evident, not as two separate images, but would so overlap as to appear as one.

This, however, is by no means the limit of visibility, and Lord Rayleigh states that isolated objects, or two bright areas separated by a dark line, may be seen if the dark line is as narrow as 1/16, and under certain conditions 1/32, of a wave-length of light, although the resulting image does not of necessity represent the actual appearance of the object. The flagellum of a bacterium, for instance, may be much beyond the limit of resolution, but is visible because it is an isolated object.

Another factor is the intensity of the incident light, and there is some reason to conclude that any relatively isolated object may be visible if it is illuminated with sufficient intensity, and can reflect light enough for the eye to appreciate. A keen observer will see in a microscopic image all structure that the best objectives can reproduce with a magnification of little more than 750 diameters, although it may be convenient to amplify the image beyond this to facilitate observation. Objects that are smaller than this limit of resolution are generally referred to as ultra-microscopic, although it is obvious that the term is not always justified. It is clear, therefore, that to define the meaning of the term "ultra-microscopic" is by no means simple, and especially in view of the fact that most methods of dark ground illumination do result in the formation of images that are not seen in other ways.

Illumination in the microscope by means of light projected at various angles to the optical axis has been common for very many years. The writer has used, for example, an oil immersion paraboloid made by Messrs. Swift and Son, probably very soon after the introduction of oil-immersion objectives, say about 1875, and the results to be obtained with it compare favourably with those of more recent introductions. At various times, other methods have been introduced. The simplest, and one of the earliest, was what is known as a "spot lens," also a dry paraboloid, and the arrangement by which the ordinary substage condenser may be utilised. In each of these a blackened stop of suitable size is placed beneath the optical portion of the illuminating system in such a position that the central axial rays are obstructed, and no light directly enters the objective. Only light refracted or reflected by the object reaches the objective, and the former, therefore, shows up brightly illuminated on a more or less dark background. With each of these arrangements only objectives of relatively low aperture can be used.

Other methods are those in which a stop is placed above the posterior combination of the objective, or the very ingenious arrangement suggested by Mr. J. W. Gordon, in which the stop, in this case a small globule of mercury, is placed above the eye-piece in the position occupied by the Ramsden disc. The closest approximation to the modern ultra-microscope of Siedentopf is the type of dark ground illumination in which the light is reflected so that it impinges upon the object at right angles to the optical axis of the microscope, but in none of these is any attempt made to confine the illuminating beam to the area under observation.

In 1903 an entirely new method of rendering visible ultra-microscopic particles was brought out by Siedentopf, and arose out of some investigations being made on various shades of ruby glass. As is probably well known, the colouring of ruby glass is dependent on small particles of gold, the dimensions of which approach in size to that of a molecule. If examined under an ordinary microscope and by ordinary methods of illumination, or by any method of dark ground illumination, even with the very best objectives there is no indication of the presence of any isolated particles. But, by a method of projecting a very thin cone of light at right angles to the optical axis of the microscope, and exactly on the spot under observation only, they were able clearly to observe diffraction discs which became visible, and arose from each individual particle of gold in the ruby glass.[1] The method is therefore one entirely depending on the arrangement and exact control of the illumination. The initial intensity of the illuminant must be high, so that only the electric arc or sunlight is suitable.

In general, the illumination of the object is accomplished by projecting the image of a very narrow precision slit, which is constructed in a similar manner to those used on fine spectroscopes so that both the length and breadth of the slit can be varied and exactly determined on to the object. The apparatus is arranged so that a very powerful beam of light is projected through the slit and focussed by a suitable optical arrangement so that the apex of the cone of rays falls exactly on the spot in the object where the objective is focussed, and so that no particles lying above or below this spot are illuminated. Consequently, only the particles in the field of view are sufficiently luminous to form an image in the microscope, and no particles lying outside this field can diffuse light and interfere with the formation of the image.

This latter disadvantage is common to all other methods of dark ground illumination, and it is in this respect chiefly, if not entirely, that the Siedentopf

[1] See Journal of the Royal Microscopical Society, 1903, p. 573.

method differs from all others. It would happen with a powerful source of light, unless the apparatus were thus arranged, that so many small particles would be illuminated that the diffraction discs would overlap and simply produce a general diffusion of light, and but very few individual particles, and of these only the more isolated ones, would therefore be visible. This is exactly what happens with any ordinary method of dark ground illumination where the particles are numerous or where they are distributed throughout a considerable area. In the Siedentopf method, where the light is simply concentrated on one spot in the field alone, little or no interference between the diffraction discs results, internal reflections between the components of the optical system are reduced to a minimum, and consequently an image is obtained which under other conditions would be impossible.

Considerable developments have taken place recently in methods of dark ground illumination. It is now possible to view such objects as bacteria with ease, without resorting to the excessive staining that is unfortunately so prevalent, enabling them also to be observed while in the living condition. The most satisfactory of these is the parabolic illuminator recently introduced by Messrs. Zeiss (Fig. 1). It may easily be said, and it is perfectly true, that the parabolic illuminator, either dry or oil immersion, is no novelty, but the one made by Messrs. Zeiss has been developed along scientific lines, and is the result of careful computation, whereas those made in the earlier days of microscopy were largely the result of chance, or at least trial and error, and it was a fortunate circumstance if they gave a result which was entirely satisfactory.

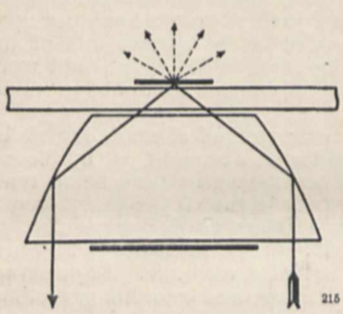


FIG. 1.

In the case of the Zeiss parabolic illuminator, the light is so reflected from the internal surface of the paraboloid that the annular cone of rays is projected, and has its focal point exactly where the objective is focussed. It would not, of course, give the same results as Siedentopf's method with such objects as ruby glass or colloidal solutions, but for observing minute living bacteria or similar transparent objects it leaves little to be desired. The illuminating rays, too, are exactly confined within the limits of a numerical aperture of 1·1 to 1·4, so that, if using, say, a 4-millimetre apochromatic objective with an aperture of 0·95, no rays would enter directly, and it would only be those reflected or refracted by the object that would pass into the objective at all, the objects, in fact, behaving as self-luminous bodies. This is a definite improvement on the method of introducing a stop into the substage condenser, so that the central rays are blocked out, and only the peripheral rays are allowed to pass, as there is much less spherical and chromatic aberration, the image being to a large extent dependent on reflected light. This appliance will render particles visible that might be termed ultra-microscopic, and in any solution or preparation of bacteria in water a great number of diffraction discs will be visible that by ordinary direct light could not be seen.

Another method that fulfils its purpose is the reflecting condenser made by Messrs. Leitz, of Wetzlar. In this, two reflecting surfaces, the one internal and the other external, as shown in Fig. 2, are so shaped as almost completely to unite the rays at a point P. The light enters from below, and takes the direction as shown by the dotted lines, ultimately converging on the point P, which is the position of the object, and is the focal point of the objective. It is obvious, therefore, that there is no chromatic or spherical aberration. The adjustments for centring are exactly the same as for an ordinary substage condenser, and the optical portion is contained in the mount that slides into the ordinary substage carrier. This apparatus, as well as the Zeiss, requires that the object-slide and the cover-glass shall be of a certain thickness, and cedarwood oil is used between the top surface of the condenser and the slide. It may be used as shown with any dry lens, but the best results are obtained with an apochromat, especially with the 4-millimetre 0·95 N.A. The cone of the illuminating rays is confined within the same limits as the Zeiss apparatus.

It is necessary to remember, however, that because a particle that is invisible by axial illumination becomes visible by oblique light, it does not, therefore, follow that it is ultra-microscopic. Its transparency may be too great, or its refractive index may too nearly coincide with the medium in which it lies for it to be visible by direct light. By oblique illumination a much smaller difference in refractive index between the object and its medium will be sufficient to form an image.

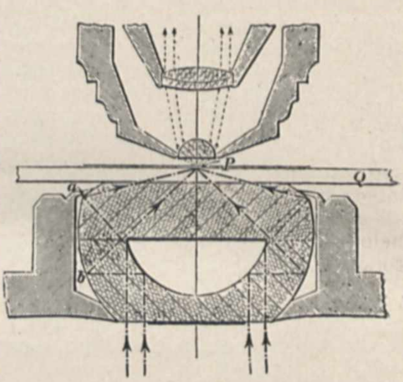


FIG. 2.

It is very difficult within the limits of a short article such as this to go into the matter sufficiently thoroughly to deal with all the points at issue. It may easily be urged that particles that are ultra-microscopic can be made visible by methods other than those described. It is well known that even passing a very powerful beam of light through a darkened room will render visible a large number of particles that cannot be seen by ordinary methods of illumination, and it is more than probable that many of the particles so observed are, in fact, ultra-microscopic. Faraday was able, by projecting a powerful beam of sunlight through a piece of ruby glass, to view the diffraction discs arising from the gold particles in the glass without any microscope at all. The whole question resolves itself really into the necessity of having primarily a sufficiently strong source of light, and so to arrange the incidence of the light that only those particles in the field of view are illuminated. In many arrangements that have been described for microscopic illumination, these two conditions have not been combined, and it is only recently that it has been thoroughly realised that either one without the other will not give the looked-for result.

J. E. BARNARD.

A PURE MILK SUPPLY.

THE importance of a supply of pure and wholesome milk can hardly be exaggerated, and during the last few years much has been done to ensure this by the education of the producer, and by the formulation of regulations by the health authorities. Contamination may take place at four stages:—(1) the cow may be unhealthy, *e.g.* tuberculous; (2) the condition of the farm and milkers and the methods employed may be unsatisfactory; (3) contamination may take place in transit; or (4) during or after sale to the consumer.

In dealing with some phases of this subject, a practical acquaintance with trade conditions is necessary, or impracticable regulations may be imposed. Thus, in a paper read by Mr. Primrose McConnell before the Royal Society of Arts,[1] reference was made to the exaggerated ideas of some sanitarians as to the cubic and floor spaces required in the byres, and, as the author remarked, if the ventilation is properly arranged for, the mere air-space in a shed is a subordinate matter.

The arm-chair sanitarian is apt to forget that one milking has to be done in the early hours of the morning—in winter in dark and cold—that disinfectants, clean smocks, and hot water may be unattainable luxuries, that in many cases all that can be hoped for is the promulgation of the doctrine of general cleanliness, and that to insist on liberal air-space and various structural conditions in the cowsheds may mean an outlay which will render the production of the milk too costly to give an adequate return to the farmer. Far be it from the writer to suggest that ideal conditions should not be formulated and put into practice whenever possible, but in all cases the regulations should be drawn up with the help of trade experts, and with a due regard to the conditions of the district.

No doubt the conditions of supply which formerly obtained, and perhaps to some extent still exist, in some of the smaller farms are much to be deprecated, but a great deal has been done, particularly by the large dairy companies of the metropolis, to remedy this. The problem of transit is still one that requires much attention; the ordinary milk churn is a dirt and dust trap by which much contamination may be introduced into the milk, and refrigerator vans need to be provided by the railway companies. The ordinary method of serving milk with a dipper, and the manner in which milk in bowls is allowed to stand on the counter by the smaller vendors amid a heterogeneous collection of other goods, are in urgent need of alteration.

To some statements made by Mr. McConnell in the paper referred to the writer would take exception. Thus, the existence of large numbers of microbes in milk, provided none was definitely pathogenic, was considered to be of no importance. But large numbers of microbes generally indicate dirty production, which in its turn facilitates the entrance of harmful bacteria. Moreover, milk swarming with microbes may in some cases produce gastro-intestinal disturbance. Tuberculin was considered to be of no value, but veterinary authorities in all countries are unanimous in regarding it as of the greatest value in the detection of tuberculosis. The careful work of the commissioners of the Royal Commission on Tuberculosis on the transmission of bovine tuberculosis to man cannot be summarily dismissed by the statement that "their far-fetched experiments and tests have not proved it to the satisfaction of many people who understand the matter just as well as they do."

R. T. H.

[1] "London Milk Supply from a Farmer's Point of View" (Journ. Roy. Soc. of Arts, December 18, 1908, p. 83).

THE DENSITY OF GASES IN RELATION TO THE ATOMIC WEIGHT OF NITROGEN.

THE fourth and last instalment of the current volume of the well-known Geneva Society's Transactions, referred to below,[1] has a special interest for the chemist and physicist from the fact that it is wholly made up of a series of communications from the laboratory of chemical physics of the University of Geneva under the direction of Prof. Ph. A. Guye. The memoirs, five in number, deal with experimental researches on the physicochemical properties of certain gases in relation to the revision of the atomic weight of nitrogen, a problem which has occupied Prof. Guye and his collaborators for some years past. The greater number of the main results have already been seen in abstract in many serial publications. The work before us contains the full memoirs, which are illustrated by carefully executed drawings of the apparatus employed.

The respective titles are:—

I. "Détermination des Densités des Gaz anhydride carbonique, Ammoniac et Protoxide d'Azote par la Méthode du Volumètre." Ph. A. Guye et Al. Pintza.

Annexe I.: "Contrôle des Densités de l'Oxygène et de l'Anhydride sulfureux." A. Jaquerod et Al. Pintza.

Annexe II.: "Essai sur la Détermination du Poids atomique de l'Azote par l'Analyse en Volume du Gaz ammoniac." Ph. A. Guye et Al. Pintza.

II. "Détermination de la Densité de l'Oxyde Azotique par la Méthode des Ballons." Ph. A. Guye et Ch. Davila.

Annexe: "Densité du Gaz acide chlorhydrique." Ph. A. Guye et G. Ter Gazarian.

III. "Sur la Compressibilité de quelques Gaz à O au-dessous de l'Atmosphère." A. Jaquerod et O. Scheuer.

IV. "Détermination des Pressions et Températures critiques de quelques Gaz." E. Briner.

V. "Résumé général." Ph. A. Guye.

The main results may be thus stated:—

The weights of the normal litre, that is, the weights of a litre of the respective gases at 0°, under a pressure of 1 atmosphere at sea level, under the latitude of 45°, are as follows:—

	Grams
Carbon dioxide	1·9768
Ammonia	0·7708
Nitrous oxide	1·9777
Oxygen	1·4292
Sulphur dioxide...	2·9266
Nitric oxide	1·3402
Hydrogen chloride	1·6398

For the values of compressibility and critical constants of these gases, as well as of those of certain methyl derivatives, we must refer to the original memoirs.

The bearing of the observations so far as they are applicable to the question of the atomic weight of nitrogen is discussed by Prof. Guye in an introductory communication. The result is to show that Stas's value of 14·04 is probably too high, as has been shown independently by Gray. The most probable value is 14·01, a number already adopted by the International Committee on Atomic Weights in its last report.

[1] "Mémoires de la Société de Physique et d'Histoire naturelle de Genève," vol. xxxv., Fascicule 4, December. (Genève: Georg et Cie., 1908.)

EDUCATION AND EMPLOYMENT.

WE are glad to see that attention is being again directed to problems of the relation between education and national welfare. In his address as president of the Association of Technical Institutions, last year, Sir Norman Lockyer referred to the deplorable national wastage that goes on after children leave the primary school, and pointed out that by permitting the half-time system the State is a consenting party to a cause of mental and physical weakness. This, as he remarked, is not a question of party politics—it is simply a question as to whether the nation is content to see the standard of height and the standard of weight of many children being reduced in order that employment of half-timers should be continued. As to the school-leaving age and the need for further education in continuation schools, Sir Norman Lockyer urged that something should be done to show that the real interests of the employers lie in the fact that if the children can be taught how to learn for a little longer time, all those in their employ, at whatever age, will be more useful to them. It was suggested that the Government should be brought into operation in the same way—the same very definite and perhaps rather drastic way—as has been done in Germany. In Germany, as Prof. Sadler shows in the valuable work on "Continuation Schools" edited by him, employers of labour are obliged to grant to all their employees under eighteen years of age attending continuation schools arranged by the Government or the local authority, the necessary *time for school attendance as prescribed* by the authority in question. Attendances at continuation schools can be made compulsory for male persons under eighteen years of age by the bye-law of a district or town council. Only in five States, representing about one-forty-sixth of the population of the German Empire, is attendance at continuation schools wholly voluntary.

Dealing with the main causes of unemployment and various proposed remedies, the recently published report of the Poor Law Commission provides useful guidance as to a desirable direction for future educational enterprise. The development of continuation schools for boys who have left the elementary school and a modification of the prevailing type of curriculum in primary schools are urged. The report condemns emphatically the widespread evil of employing boys who have just left school in immediately remunerative but uneducative occupations which lead nowhere and provide them with no special knowledge to ensure their employment later in life. The Commissioners

regard with favour the suggestions that boys should be kept at school until the age of fifteen instead of fourteen; that exemption below this age should be granted only for boys leaving to learn a skilled trade; and that there should be school supervision until sixteen, and replacing in school of boys not properly employed.

Experience has shown that a long time may elapse before the recommendations of a Royal Commission are translated into Acts of Parliament, but, in view of the powers given to Scottish school boards by the recent Education Act for Scotland, it may be hoped that it will not be long before something is done to give the English boy from the elementary school an education and training in his teens which will ensure his becoming a skilled worker when manhood is reached.

The Commissioners, we are glad to note, have not ignored the necessity for providing during the years of adolescence suitable technical instruction for the boys upon whose ability as skilled artisans our industrial efficiency as a nation will in the future depend. The report insists that

There is urgent need of improved facilities for technical education after the present age for leaving school. With a view to the improvement of physique, a continuous system of physical drill should be instituted, which might be commenced during school life, and be continued afterwards; and, in order to discourage boys from entering uneducative occupations which offer no prospect of permanent employment, there should be established, in connection with the Labour Exchange, a special organisation for giving boys, parents, teachers, and school managers information and guidance as to suitable occupations for children leaving school.

We can imagine no more effective method of reducing in future years the ranks of the unemployed than that recommended in the report. The problem is first to educate the parents to forego the advantage of their boys' immediate earnings—providing them with some solatium, if necessary—and then to provide the boy with suitable employment which will enable him to learn a trade, and to be a skilled worker in his manhood. To convert him into a competent artificer it is necessary to see that the boy attends the technical school during his apprenticeship, or corresponding years, for a certain number of hours which form part of his working day.

But, as has been pointed out in these columns again and again, the full advantages of a scheme of technical instruction cannot be secured unless the boys attending the classes of the technical institute have received an adequate and suitable education in the elementary school during the years up to fifteen. In the past, the type of curriculum and the general character of the education have been unsuitable for boys who will later become manual workers. The Commissioners have recognised these facts, and they recommend the Board of Education earnestly to consider the necessity for re-modelling the practice and ideals of our elementary schools. To quote the report:—

A considerable amount of evidence has been submitted to us to the effect that the present system of elementary education is not adapted to the wants of an industrial community. There is a consensus of feeling, in which we ourselves concur, that the present education is too literary and diffuse in its character, and should be more practical. It should be more combined than at present with manual training. It is not in the interests of the country to produce by our system of education a dislike of manual work and a taste for clerical and for intermittent work, when the vast majority of those so educated must maintain themselves by manual labour. If school training is to be an adaptation of the child to its future life and occupation, some revision of the present curriculum of public elementary schools seems necessary.

Men of science will welcome this full and generous recognition of the claims of "practical" subjects to take a large part in the education of children who will later constitute our industrial community—a necessity which was urged in the report of the British Science Guild Committee, published in NATURE of January 28 (p. 283). Manual work must be treated with respect, and every effort made to explode the prevalent fallacy that ill-paid and precarious clerical work is more "respectable" than honest, skilled constructive labour.

Since the publication of the report of the Commission an influential and representative deputation has waited upon the Prime Minister on the subject of boy labour, and many of the considerations here passed in review were urged upon the Government. In replying, Mr. Asquith dealt in an illuminating and sympathetic manner with the years between leaving school and reaching manhood—the unbridged gap, as he called it. After endorsing to a large extent the recommendations of the recent report, Mr. Asquith dealt with some of the education difficulties. He said:—

I think the most interesting and suggestive part of the discussion to which we have listened this afternoon has been upon the subject of the exemption, the raising of the age of exemption, and of enlarging the use, perhaps by compulsion, of continuation schools. I am entirely with you, I think, in the most advanced views that have been offered to-day upon both these matters; but being compelled by the exigencies of the life I lead to deal with these matters in a practical spirit—in other words, to calculate the length, the breadth, and the weight of the obstacles which have to be encountered—the remedy is not quite so easy to discover and to apply as to the more sanguine among us it may, at first sight, appear. For instance, there is this question of raising the age of exemption. There you are confronted with these discouraging figures from the Lancashire operatives, where, upon a poll on the question of raising the half-time age to thirteen, barely 34,000 voted in the affirmative and no less than 150,000 voted in the negative. I agree that a few years ago the figures would have been much more discouraging than they are now. But one hopes that with the advance of information and the efforts of the enlightened leaders like my friend Mr. Shackleton there may be a considerable movement in a better direction. But it is obvious that at the moment it would be extremely difficult to apply by any statutory form of compulsion a measure which, so far as regards the great bulk of the operatives are concerned, a large majority are not prepared voluntarily and spontaneously to accept. That is a case for what is called spade-work, which I hope may produce its results before long. When we come to the question of continuation schools, I think the prospect is more satisfactory and hopeful. We did something for Scottish education in the Scottish Act last year, and I hope it is not too sanguine a view to take if one expresses the hope that England will soon level itself up to the standard of Scotland in that matter. Again there is a difficulty. As one of the speakers pointed out, if the boys or the girls are kept hard at work in a monotonous way at unintellectual occupations during a great many hours of the day, you cannot expect them to bring to the continuation school, or evening school, anything like a fresh intelligence or that power of receptivity which is essential to the efficient working of such institutions. There comes in that question of the half-timer again. I cannot help thinking that if employers of labour would more generally take the course which Sir Albert Spicer has taken, and which Mr. Cadbury has taken, of making it a condition when they employ these young boys and girls in their works that they should spend one or two evenings in a continuation school, their regular hours of labour being so adjusted that it is not an excessive strain either upon their intellectual or physical capacity, we should find, if not a solution, the way of going very near to the solution of that part of the problem.

A report upon the problem of education in relation to apprenticeship, especially as it concerns the children of London, is to be presented by the Higher Education Sub-committee of the London County Council Education Committee at a meeting to be held as we go to press. In this report the committee urges that, inasmuch as industrial training is a national and not a local question, technical institutions and technical scholarships should be supported to a much larger extent than at present out of funds provided by the National Exchequer.

As remedies for what are pronounced defects in our educational methods, leading to waste of effort and the sacrifice of future prospects to immediate needs, the committee makes a number of proposals which are identical in principle with suggestions for an organised educational system contained in the report of the British Science Guild Education Committee already published in these columns. The proposals put forward by the London County Council Committee may be summarised as follows:—

(1) The age of compulsory attendance at elementary schools should be raised to fifteen.

(2) Certain children should be transferred at the age of thirteen to trade or craft schools.

(3) The elementary-school curriculum should be made more practical by a considerable increase in the time devoted to various kinds of manual training.

(4) Local education authorities should be empowered to compel employers to allow their apprentices and learners the necessary time during the day to attend classes, and to enforce such attendance on the apprentices and learners.

(5) At least half the working day should be spent in school.

(6) All boys and girls not on the rolls of trade or secondary schools should be required to pass through a three years' course of "half-time" instruction at continuation schools.

It is to be hoped that statesmen will not wait until a mandate is received from those who benefit by child-labour before attempting to make our educational demands comparable with those of Scotland and Germany. Their duty is to safeguard the mental and physical welfare of the coming generation if our nation is to be kept in the van of progress. The continuation of the present system involves grave injustice to a not inconsiderable part of the child population of England, for the mental, moral, and physical training received during school life is soon lost after a boy drifts into one of the occupations of unskilled trades. As to further education, whether in day or evening continuation schools, or in secondary schools, there is much to be done before we can approach the conditions existing in Germany. While Germany is fast extending the age of compulsory attendance through the critical years of youth, in England and Wales not more than one in three of the children who leave the public elementary schools at thirteen or fourteen years of age receives any further systematic care as regards education of any kind. When our statesmen realise what a study in contrasts is afforded by the German and English systems of education, and what an inferior position we occupy, judged by any standard of educational measurement, they will perhaps do something to prevent the waste of body and mind which is a source of individual poverty and of national weakness.

SIR GEORGE KING, K.C.I.E., F.R.S.

SIR GEORGE KING, K.C.I.E., F.R.S., whose death at San Remo was announced in NATURE of February 18, was born at Peterhead on April 12, 1840. He was educated at the Grammar School and the University, Aberdeen, graduating in medicine in 1865. In the same year he entered the Indian Medical Service, and was posted to the Bengal Presidency.

Soon after reaching India, King was detailed for military medical duty in Central India and Rajputana, where his leisure was devoted to work of high quality as a field naturalist. From military duty he was transferred to act temporarily as superintendent of the Botanic Gardens at Saharanpur, in Upper India; shortly thereafter he was induced to join the Indian Forest Service, and was placed in charge of the Kumaon forests. While so employed he was selected by the Secretary of State for India as successor to Dr. Thomas Anderson, whose death in October, 1870, had left vacant the superintendentship of the Royal Botanic Gardens at Calcutta and of Cinchona Cultivation in Bengal.

When, in 1871, King assumed charge of the Calcutta gardens these were in the ruined condition to which they had been reduced by severe cyclones in 1864 and again in 1867. They had practically to be renovated, and the charm and beauty for which they are famed constitute an adequate memorial to King's energy, patience, and skill as a landscape gardener. The prolonged task involved considerable expenditure, and the readiness with which the necessary funds were supplied bears witness to the traditional enlightenment of the Government of Bengal and to the confidence which King's organising powers inspired.

The cinchona department was just passing beyond the experimental stage when King was given control. Natural causes render the cultivation of cinchona in northern India unprofitable to private enterprise. Notwithstanding this fact, King so administered the Government plantations and factory that the Government was able, without incurring pecuniary loss, to place the remedies against malaria which cinchona bark yields within the reach of the poorest peasant in India.

The extent and gravity of King's administrative duties did not prevent him from prosecuting the botanical studies which made him one of the leading systematic botanists of the last quarter of the nineteenth century; but with rare self-denial he forbore the publication of his results until the tasks of restoring the gardens and organising the plantations and factory under his charge had progressed so far as to justify his giving the time that was needed to the preparation of ordered statements. But the fact that his scientific attainments were on a level with his administrative powers could not remain concealed from those with whom he corresponded on botanical subjects, and in 1884 he was promoted to the degree of LL.D. by his own university, while in 1887 he was elected into the Royal Society.

In the last-mentioned year the enlightened policy of the Government of Bengal enabled King to found the "Annals" of the Calcutta gardens, a series of sumptuous volumes in which he proceeded to enrich systematic study by providing monographs of difficult and important genera like Ficus, Quercus, Castanopsis, Artocarpus, Myristica, and families like Magnoliaceæ, Anonaceæ, and Orchidaceæ. These contributions to natural knowledge are characterised by the accuracy, lucidity, and completeness which marked everything he did. But as regards the branch of botany of which he thus became so distinguished an exponent, King was influenced by the sense of duty that had so long delayed the publication of his results. His personal predilections were towards problems other than systematic, and, as might be expected in one who had been a favourite pupil of the late Prof. Dickie, F.R.S., these were problems associated with cryptogamic studies. But King's practical mind realised that, important and enticing as such studies are, the path of duty for him led elsewhere. The greatest immediate service he could render to the official and commercial interests of India lay in the provision of recognisable descriptions of hitherto unknown or imperfectly understood phanerogamic plants of economic importance, and especially, as his experience as a forest official had taught him, recognisable descriptions of trees, too frequently neglected by workers whose study of herbaceous plants and shrubs may leave nothing to be desired. To this task King devoted himself in the most single-minded fashion, and in furthering it he commenced in 1889 the publication of the results of a sustained floristic study of the vegetation of the Malayan peninsula, issued from time to time in fascicles that were professedly intended to serve as precursors to a flora of that region, but are so admirably executed that they serve as an efficient substitute for such a work. In 1891, when the various botanical officers in India were linked together in one department, King became the first director of the Botanical Survey of India.

During his Indian career King was able to render much additional service to the country and its Government. He was long a trusted member of the Senate, and served for a term on the syndicate of the University of Calcutta. He was a member of the board of visitors of the Bengal Engineering College, an institution in which he took a warm and effective interest. He was an original member of the committee of management of the Zoological Gardens at Calcutta, the site of which he found occupied by a collection of hovels, and converted into a singularly attractive place of public resort. He was for many years a trustee of the Indian Museum, and for a time was chairman of the trust. He was president of the central committee appointed by Government to investigate the indigenous drugs of India, from its inception in 1894 until his retirement in 1898 after thirty-three years of devoted service to the people and the Government of India.

After his retirement King gave all his energies to the continuation of his "Materials for a Flora of the Malayan Peninsula." But his health, severely tried by his long residence in the East, became gradually more and more impaired, and he realised that he might never see the completion of the work he had allotted himself. His friend Mr. H. N. Ridley, F.R.S., director of the Botanic Gardens, Singapore, stepped into the breach and undertook the elaboration of the monocotyledonous families while King was engaged on the remainder of the dicotyledonous ones, and after 1902, when the thirteenth fasciculus, completing the Calycifloræ, was issued, another friend, Mr. J. S. Gamble, F.R.S., became associated with him in working out the Corollifloræ. Increasing infirmity gradually led to King taking less and less of an active share in the work, and the later families have been elaborated by Mr. Gamble alone.

King's skill as a landscape gardener led to the award of its Victoria medal by the Royal Horticultural Society. His services to humanity in connection with the manufacture and distribution of the alkaloids of cinchona bark were recognised by honorary membership of the Pharmaceutical Society, by the grade of "Officier d'Instruction publique," and by the gift of a ring of honour by H.I.M. Alexander III. of Russia. His invaluable contributions to natural knowledge brought him honorary association with a number of learned societies, and the award of medals by the University of Upsala and the Linnean Society of London, while his administrative qualities were recognised, on the eve of his retirement, by the Government of India.

King was keenly interested in art, in literature, and in many branches of science other than that in the promotion of which he took so active a part. With wide and accurate knowledge he combined a kindly sense of humour and a magnetic charm of manner which rendered intercourse with him a privilege never to be forgotten, and to his many friends his death leaves a blank that cannot be filled.

NOTES.

AT the meeting of the Royal Society on Thursday, February 18, telegrams of congratulation on the hundredth anniversary of the birth of Charles Darwin were read from the University of Christiania, the University, Kharkoff, the Naturalists' Students' Association, Kharkoff, the Society of Naturalists, Kharkoff, the council of lecturers, Moscow Women's University, and the Swedish Academy of Sciences, Stockholm. The president reported that telegraphic acknowledgments and thanks had been transmitted to the senders on behalf of the Royal Society.

M. H. POINCARÉ has been elected president of the French Bureau des Longitudes; M. Bigourdan becomes vice-president, and M. Deslandres secretary.

PROF. W. M. DAVIS was elected president of the Association of American Geographers at the recent annual meeting held in affiliation with the American Association for the Advancement of Science.

THE death is announced of Prof. Victor Egger, professor of philosophy and psychology at the Sorbonne, and distinguished chiefly by his work in psychology. We also notice with regret the announcement of the death of Prof. Carroll D. Wright, professor of statistics and social economics at Clark University, Worcester, Mass., and distinguished among American statisticians and economists.

WE notice with regret the announcement that Dr. D. J. Hamilton, formerly professor of pathology at Aberdeen University, died on February 19 at sixty years of age. Prof. Hamilton was for several years demonstrator of pathology at Edinburgh University, and was appointed in 1882 to the chair of pathology at Aberdeen University, which he resigned last year owing to ill-health.

A CORRESPONDENT writes asking for information concerning "arboreal tumours" which are to be observed attacking trees in certain damp, low-lying districts, and eventually leading to the destruction of the trees. A reference to Kew enables us to state that the subject is dealt with in the late Prof. H. Marshall Ward's "Diseases of Plants," published in the Nature Series of Messrs. Macmillan and Co., Ltd. The matter is lucidly discussed in chapter xxiv. of this work at pp. 222 *et seq.*

WE learn from the *Times* that a fresh attempt is being made to introduce the salmon into New Zealand. Similar attempts have been made previously on more than one occasion, but without success, which is the more remarkable as the acclimatisation of the trout was effected many years ago with the most satisfactory results, many of the New Zealand rivers being now well stocked, and the fish growing to a very large size. The difficulty seems to consist, not so much in getting the eggs to New Zealand in a healthy condition, as in preserving the young fish after hatching. About a million ova have lately been dispatched from London under the direction of Mr. Luke Ayson, the Chief Inspector of Fisheries of New Zealand, and it is hoped that success will attend the new venture.

THE anniversary meeting of the Geological Society of London was held on Friday, February 19, when the officers for the ensuing year were elected as follows:—*President*, Prof. W. J. Sollas, F.R.S.; *vice-presidents*, Mr. G. W. Lamplugh, F.R.S., Mr. H. W. Monckton, Dr. J. J. H. Teall, F.R.S., and Prof. W. W. Watts, F.R.S.; *secretaries*, Prof. E. J. Garwood and Dr. A. Smith Woodward, F.R.S.; *foreign secretary*, Sir Archibald Geikie, K.C.B., Pres.R.S.; *treasurer*, Dr. Aubrey Strahan, F.R.S. The medals and funds awarded, as announced in NATURE of January 21 (p. 347), were then presented. The president delivered his anniversary address, which dealt with time, considered in its relation to geological events, and to the development of the organic world.

BY the will of the late Dr. Francis Elgar, F.R.S., the sum of 1600*l*. is left to the Institution of Naval Architects for the endowment of a scholarship to be awarded as the council may decide, but the hope is expressed that the scholarship will be similar to that given by him during his life. After making other bequests, one-half of the residue (which will apparently amount to between 32,000*l*. and 34,000*l*.) is eventually to be divided equally between the Institution of Naval Architects for the encouragement of the science and art of naval architecture, and the University of Glasgow, to be held upon trust for the furtherance of the objects of the John Elder chair of naval architecture in that University.

AT the annual general meeting of the Physical Society on January 12 the following officers and council were elected for the ensuing year:—*President*, Dr. C. Chree, F.R.S.; *vic-presidents*, those who have filled the office of president, together with Mr. W. Duddell, F.R.S., Prof. A. Schuster, F.R.S., Mr. S. Skinner, and Dr. W. Watson, F.R.S.; *secretaries*, Mr. W. R. Cooper and Dr. S. W. J. Smith; *foreign secretary*, Prof. S. P. Thompson, F.R.S.; *treasurer*, Prof. H. L. Callendar, F.R.S.; *librarian*, Dr. W. Watson, F.R.S.; *other members of council*, Mr. A. Campbell, Dr. W. H. Eccles, Dr. A. Griffiths, Dr. J. A. Harker, Prof. C. H. Lees, F.R.S., Mr. T. Mather, F.R.S., Dr. A. Russell, Prof. E. Rutherford, F.R.S., Mr. F. E. Smith, and Mr. R. S. Whipple.

THE Washington correspondent of the *Times* announces that the State Department is preparing invitations, which will be sent out as soon as possible, for an international world conference at The Hague next September to consider the conservation of natural resources. In making this announcement, President Roosevelt said that, even though no great and important immediate results were derived from the conference in the direction of conservation, he hoped that all nations would be represented. The first immediate result of the conference is expected to be a general inventory of the natural resources of the world. An effort will be made to ascertain how the world stands regarding such resources, with discussion on what has been done by different nations towards conservation, what is best to do, and what may be reasonably expected.

MATERIAL for a series of illustrated lectures on the results which have been obtained by recent discoveries in the prevention or treatment of disease has been prepared by the Research Defence Society. A number of lantern-slides illustrative of progress and discovery in respect of malaria, yellow fever, sleeping sickness, Malta fever, diphtheria, &c., have been made, and the slides are accompanied by full descriptive catalogues, with notes and references, and a print of each slide, for the use of lecturers. The society is willing to lend these materials for lectures to accredited persons who are in sympathy with the excellent object of disseminating sound and trustworthy information on the aims and achievements of research in medicine and physiology. In certain cases the society is prepared to send a lecturer, and at all times will lend every assistance to ensure the success of a lecture to a good audience. Communications and inquiries on this subject should be addressed to Mr. Stephen Paget, hon. sec., 70 Harley Street, W.

AN interesting gathering of the Leeds Naturalists' Club was held on February 15 to celebrate the Darwin centenary. Mr. Harold Wager, F.R.S., delivered an address on Charles Darwin, in which he reviewed the life of the great naturalist, the unselfishness of both Darwin and Wallace in respect of their simultaneous discovery, the development of the hypotheses by Darwin himself and by Haeckel, Weismann, and Mendel. There was an interesting exhibit by the president of the club (Mr. W. Denison Roebuck) in the form of a lithographic facsimile of the illuminated address which a deputation, representing the naturalists of Yorkshire, headed by the late Prof. W. C. Williamson, F.R.S., presented to Darwin in November, 1880, in celebration of the coming of age of the "Origin of Species," and the autograph letter in which Darwin acknowledged the compliment. Subsequently a resolution was adopted congratulating Dr. Alfred Russel Wallace, O.M., on the completion last year of fifty years from the simultaneous publication by the Linnean Society of the papers by Darwin and himself, in which the influence of variation and natural selection in the development of species was described.

IN NATURE of January 28 reference was made to the earthquake which was recorded by seismographs in India, Europe, and South Africa on January 23. Its origin was provisionally placed in western central Asia, but now proves to have been further south, in the Luristan district of Persia, about two days' journey from Burujird, where fifty villages are said to have suffered and 5000 lives to have been lost. This earthquake illustrates the difficulty which sometimes arises in fixing an origin from distant records; the European and Indian records gave a locus in the form of a band running about north-north-eastwards through the country east of the Caspian Sea, but did not permit of fixing it more closely. The Cape of Good Hope record should have supplied the data for doing this, as the observatory lies almost on the continuation of this locus, but that the earthquake, being no greater than that of Messina, the first tremors failed to impress themselves on the seismograph; this loss of the commencement of the disturbance made it impossible to determine the exact situation of the origin, and suggested that it was not, as has actually proved to be the case, at the nearest end of the strip of country indicated by the Indian and European records.

THE *Nineteenth Century* for February contains a paper by Dr. C. Davison on the Messina earthquake, illustrated by two sketch-maps, one showing the principal isoseismal lines of the earthquake, the other the seismic zones of southern Calabria, as delineated by Dr. M. Baratta. The places that were partly or entirely destroyed lie within three nearly circular curves, the most important including Messina, Reggio, and Pellaro, and having its centre beneath the Straits of Messina, the others in the neighbourhoods of Palmi and Monteleone respectively. The total area of these curves is estimated at about 500 square miles, and the disturbed area, including the portion covered by the sea, at about 150,000 square miles. The recent earthquake, like those of 1783 and 1905, was thus polycentric. In 1905, as in 1908, the different centres (namely, those near Palmi, Monteleone, Nicastro, Cosenza, and Bisignano) were in action simultaneously, or nearly so. In 1783 they came into action successively, the first great shock taking place in the Palmi zone, the second in that of Scylla, the third in the Monteleone zone, the fourth, as recently, in the Messina zone, the fifth in the Monteleone zone, and the sixth in the Girifalco zone. In other earthquakes single centres appear to have been in action, the Palmi zone in 1894, the Monteleone zone in 1659, the Nicastro zone in 1638, the Cosenza zone in 1854, and the Bisignano zone in 1836. Thus there appear to be several more or less detached centres of maximum disturbance, though their simultaneous activity in 1905 and 1908 indicates that there must be some deep-seated connection between them.

SEVERAL reports of scientific interest were referred to in the report of the council of the Institution of Mechanical Engineers, presented at the annual general meeting on Friday, February 19. Since October, 1907, an investigation for the Alloys Research Committee has been in progress in the metallurgical department of the National Physical Laboratory on the ternary alloys of copper-aluminium, and a report dealing with copper-aluminium-manganese is expected shortly. The results of the prolonged sea-water corrosion tests, which have been carried on at Portsmouth Dockyard on the specimens of copper-aluminium alloys, referred to in the eighth report, will be published with the next report of the committee. The research in connection with gas-tightness and steam-tightness of metal castings is being continued at the University of Manchester. The three new subjects selected for investigation in accordance with the vote of the members, referred to in the last annual report, have received attention during the year. A comprehensive report upon the transfer of heat across metallic surfaces in contact with water and with gases will shortly be brought before the institution for reading and discussion. Reports are also being prepared upon the features of refrigerating machinery in which further investigation is needed, and the action of steam passing through nozzles and steam turbines.

WE have received a newspaper cutting containing the report of the Port Elizabeth Museum for 1908, from which we learn that great efforts are being made by the president to develop that institution, especially from the point of view of local education. These endeavours are, however, considerably hampered by lack of sufficient financial resources. Several important additions were made to the collections during the year. The number of visitors who passed the turnstiles was considerably less than in 1907.

IN the February number of *Naturen* Dr. L. Stejneger adduces further evidence in favour of the theory of the existence, at a comparatively recent date, of a land-bridge between Scotland and Scandinavia. This evidence is mainly based on the distribution of the species, or races, of charr (Salvelinus), which is illustrated by a map. *Salvelinus alpinus* is considered to be common to western Scandinavia and Scotland, while in eastern Scandinavia we have the typical *S. salvelinus* of the Alps. Iceland is the home of *S. nivalis*, while further north occur *S. insularis* and *S. stagnalis*. Lapland is the home of an intermediate form known as *S. salvelino-stagnalis*, while another annectant type, *S. alpino-stagnalis*, occurs in Greenland.

HAVING completed the investigation of the degenerate eyes of the Australian marsupial mole (Notoryctes), Miss G. Sweet has directed her attention to those of the African golden moles (Chrysochloris), the results of this later study being published in vol. liii., part ii., of the *Quarterly Journal of Microscopical Science*. In the Chrysochloridæ the eye has sunk only into the dermis, where it is surrounded by the hair-roots; but the eye-muscles have disappeared, as has the vitreous humour, while the lens and iris are very degenerate. The optic nerve is retained in some instances and lost in others. Despite its comparatively superficial position, the eye is not visible externally; the loss of the eye-muscles is an unusual feature. That the eye, even were the cleft at the proper angle for admitting light-rays, is quite useless for vision is certain, and it is improbable that it is capable of detecting even degrees of lignt.

GREAT interest attaches to a paper by Mr. G. R. Wieland in the February number of the *American Journal of Science* on the structure of the Cretaceous marine turtles of the Protostegidæ, since the facts therein adduced go a long way, at any rate in the author's opinion, to solve the problem of the relationship of the leathery turtle (Dermochelys) to ordinary turtles (Chelone). These turtles, as represented by Protostega and Archelon, attained gigantic dimensions, and, in accordance with the needs of a pelagic existence, lightened the carapace by a great reduction in the size of the costal plates, which are more aborted in the type-genus than in the modern Chelone, thus leaving very large intercostal vacuities. The reduction is carried to a still greater degree in Archelon, the absorption process being also extended to the neural bones, many of which, so far as can be seen, appear to be reduced to thin films. Upon the neurals in this genus are, however, superimposed a series of digitate epineural dermal bones, which correspond to the neural keel of Dermochelys, and discharge the function of the aborted neurals. It is added that in life Archelon must have possessed a leathery hide, with a system of keels similar to those of the leathery turtle. In conclusion, the author observes "that of the two camps which have attacked the difficult and highly attractive problem of the origin of Dermochelys, those favouring the view of a close relationship to ordinary turtles and a comparatively recent origin have rather the best of the argument." It seems, in fact, that Dermochelys and its allies, having become less pelagic in habits than ordinary turtles, found the reduction in the bony framework of their carapace a disadvantage, and they accordingly developed a secondary structure of overlying dermal bones to take the place of the proper carapace, which then underwent a still further reduction, and finally vanished.

THE January number of the *Psychological Review* (Baltimore) contains a further contribution to the study of galvanometric deflections which they ascribe to psychological processes in man. This branch of work, which was started by Dr. Petersen, has led the authors to the conclusion that active emotional processes in man bring about electromotive forces, and consequent galvanometric deflections. These results have been the subject of somewhat sensational articles in the lay Press, but it is wise at present to withhold judgment on their interpretation. Voluntary muscular movements, secretion of the glands in the skin and other parts, the cardiac activity, and the action of other internal organs are all accompanied with electrical changes, and although the authors claim to have eliminated currents due to these causes, we do not think that physiologists accustomed to the study of electrophysiology by the use of the galvanometer or electrometer will be convinced that such is the case. The very erratic galvanometric movements described are just what we would anticipate in the bewildering intermixture of physiological activities which the intact human body presents. To conclude that they are produced in the anatomical correlate of various psychical phenomena is, to say the least of it, extremely premature.

FOLLOWING upon a study of the genus Pentstemon in the Western States, Dr. L. Krautter has compiled a list, with diagnoses, of American species, that is published as vol. iii., No. 2, of the Contributions from the Botanical Laboratory of the University of Pennsylvania. The arrangement of the sections as drawn up by Asa Gray has been followed, but whereas Gray's last contribution recognised eighty species, the present collation includes nearly a hundred and fifty species.

WHILE afforestation is providing a topic of general discussion, it is opportune to refer to the Chopwell Woods, an area of 930 acres near Newcastle, that was made over by the Commissioners of Woods in 1904 to Armstrong College. The working plan, by Mr. J. F. Annand, is briefly noted in the Transactions of the Royal Scottish Arboricultural Society (vol. xxii., part i.). The soil varies from stiff clay through loams to sand and pebbly gravels; the old plantations, chiefly of oak, larch, or Scots pine, are none of them productive. It is proposed now to grow various coniferous trees. Larch will be planted on the best-drained loamy soil, Scots pine on the poorest, and spruce will be tried on moist soil. Corsican pine, Sitka spruce, and Douglas fir will also receive a trial.

A BOOK on trees and shrubs, native or introduced, to be published in sixteen parts, at the price of one shilling the part, is announced by Messrs. J. M. Dent and Co. The main object of the book is to provide descriptions for identifications of the plants, while short details regarding cultivation and origin have been given. Beginning with the Ranunculaceæ, the genera Clematis, Magnolia, and Calycanthus are treated in the first part. The authors, Messrs. C. S. Cooper and W. P. Westell, have perforce limited the species of Clematis to three, but ten of the Magnolias are described. The general plan is well conceived, and the text bears evidence of careful compilation, but a striking omission occurs in the absence of the names of the authorities for the specific binomials. The black-and-white artistic drawings by Mr. C. F. Newall are chiefly intended for diagnostic purposes, and sixteen coloured illustrations will serve to delineate general habit.

COLONEL PEASE, Inspector-General of the Indian Civil Veterinary Department, in the October (1908) number of the *Agricultural Journal of India*, records a discovery of much importance to poultry fanciers in the East. No more fatal disease than that hitherto known as "fowl cholera" is found in India. Quite accidentally, Conductor Dare at Mian Mir, while studying the surra disease in camels, ascertained by the use of the microscope that the death of some ducks from "cholera" was really due to a specific organism of the Spirochætes type. It is spread by the agency of the *Argas persicus*, or common fowl-tick, which it is difficult to destroy. The best method of dealing with it is to burn the old roosts and nests; but scraping the walls of the fowl-houses, painting them with hot coal tar, and brushing the feathers of the birds with paraffin have been found efficacious. Now that the disease has been traced to this parasite, a suitable form of treatment will doubtless soon be discovered.

THE Weather Bureau of the Philippine Islands has issued an advance chart showing the approximate tracks of four typhoons that crossed the archipelago from September 23 to October 13, 1908. The first and fourth of these were remarkable for the terrific violence of the winds; the latter, also, for the great floods which swept the Cagayan Valley during the passage of the cyclonic centre. These typhoons will be discussed, in due course, in the bulletins for the respective months; the last number received is for February, 1908, and contains a catalogue of Philippine earthquakes for February, 1890–1907. The Manila Observatory, like those of Hong Kong and Zikawei, has published a typhoon-warning code; it is intended principally to lighten the burden generously borne by several telegraphic companies by the free transmission of reports between the chief meteorological services in the Far East.

To the Proceedings of the Rhodesia Scientific Association, vol. vii., part ii., Messrs. F. White and E. C. Chubb contribute a paper on a cave containing fossilised bones, worked pieces of bone, stone-implements, and quartzite pebbles. The cave is situated in a small hill of zinc and lead ores in north-western Rhodesia, and an account of its contents was given in the *Geological Magazine* for October, 1907. With the exception of a humerus and tibia of a rhinoceros, all the mammalian bones specifically identified are referred to existing forms. The rhinoceros bones are, however, considered to indicate an animal of slighter build than either of the living species, and are therefore regarded as belonging to an extinct form, for which the name *Diceros whitei* is suggested.

The Austrian Meteorological Office has issued, as part ii. of the "Climatology of Austria," a discussion of the observations at Trieste for the sixty years 1841–1900, by Mr. E. Mazelle, director of the maritime observatory at that place. In addition to its importance as a contribution to climatology, the discussion of this long series is intended to serve as a basis for the "reduction" of mean values in neighbouring localities for shorter periods to one of similar length. The tables contain, *inter alia*, mean and extreme values for yearly, five-yearly, and ten-yearly periods. The mean annual temperature of Trieste for the sixty years was 57°·4; July, 75°·6; January, 40°·1. The absolute maximum for thirty-two years (1869–1900) was 99°·5 (July, 1873); the minimum, 14°·0 (February, 1870); but in January, 1907, a reading of 9°·0 was recorded. The annual rainfall is approximately 43 inches; the wettest month is October, and the driest February; rain falls on an average on 109 days in the year.

The past week was exceptionally fine and dry over the whole of Great Britain, and the weather was practically rainless in all parts of England. The aggregate measurement of rain for February is likely to prove very much below the average over the entire area of the British Isles. At Greenwich the rainfall to February 24 was 0·32 inch. In February, 1891, the total measurement of rain at Greenwich was 0·04 inch, so that the present month is far from establishing a record in this respect. The duration of bright sunshine was everywhere large, and in England the weather was exceptionally brilliant. For the five days from February 18–22 inclusive, the sun shone for forty-two hours at Greenwich, where the average duration for the month is fifty-seven hours. Sharp frosts have occurred at night over England. At Greenwich the exposed thermometer on the grass fell below 20° on each night during the last week, and on three nights it fell to 11°. Frost also occurred each night in the shade, and on the morning of Tuesday, February 23, the thermometer in the screen fell to 19°, which is lower than any reading so late in February during the last sixty years. The day temperatures have been fairly high for the time of year, due to the bright weather, and on the four consecutive days from February 19–22 the thermometer in the sun's rays exceeded 90°, and on Monday, February 22, it rose to 97°. The fine and dry spell of weather over England was due to the prevalence of anticyclonic conditions, a region of high barometer readings being situated over the United Kingdom.

Natural science and the healing art formed the subject of Prof. Tschirch's rectorial address at the anniversary festival in the University of Bern in November last ("Naturforschung und Heilkunde," by Prof. A. Tschirch. Pp. 30. Leipzig: C. H. Tauchnitz, 1909. Price 1 mark). This ancient seat of learning can boast many great names in the past, and the new rector was able to point to Haller, among others, who recognised the importance of natural science in the progress of medicine. Growth in the knowledge of science has been accompanied by an increase in the means the physician and surgeon possess in grappling with disease. Chemistry is no longer a mere handmaid of medicine, though biochemistry may be regarded as one of the most important factors in the future progress of medicine. The subject is throughout treated in a philosophical manner, and the address will well bear careful perusal.

According to a note in the January number of the Journal of the Franklin Institute, the Forest Service at Washington is watching with interest the substitution of cement for wood as a building material. While the demand for timber has remained almost stationary, the production of cement has increased in the last five years from 25 to 50 million barrels.

Le Radium for January contains a table of radio-active constants compiled by eleven well-known workers in the field of radio-activity. The constants tabulated for each substance are:—the atomic weight, the time constant, the half-decay time, the mean life, the nature of the radiation, the mean path in air of the emitted α rays, the thickness of aluminium which will stop those rays, and the thickness necessary to reduce the β and γ rays to half intensity. The table will be very useful, not only as a record of what is already known, but as an indication of the lacunæ which remain to be filled.

The report of the International Committee on Atomic Weights for 1909 contains a discussion of researches dealing with the atomic weights of hydrogen, chlorine, sulphur, lead, cadmium, tellurium, rhodium, palladium, europium, erbium, ytterbium, columbium, and radium. The changes proposed are:—chlorine, from 35·45 to 35·46; sulphur, 32·06 to 32·07; lead, from 206·9 to 207·1; tellurium, 127·6 to 127·5; palladium, from 106·5 to 106·7; columbium, from 94 to 93·5; radium, from 225 to 226·4. A general revision of the whole table of atomic weights has been made on the basis of the following fundamental data:—when O = 16, H = 1·008, C = 12·000, N = 14·007, Cl = 35·460, Br = 79·916, Ag = 107·880, K = 39·095, S = 32·070. The changes introduced by this re-calculation are small and comparatively unimportant.

Since the time of Prout, the calculation of the atomic weights of the elements by means of a formula has been a favourite speculation. Some of the earlier attempts were considered satisfactory by their proposers if the calculated and experimental values agreed within a unit or two, and were, moreover, usually based on an empirical formula. Two recent attempts in this direction (A. L. Bernouilli, "An Atomic-weight Formula on the Basis of the Law of Mass Action and Avogadro's Law," *Zeitschrift für physikalische Chemie*, January 26, and A. C. G. Egerton, "The Divergence of the Atomic Weights of the Lighter Elements from Whole Numbers," read before the Chemical Society on February 4) fall in a different category. The formulæ are proposed on a definite physical basis, and the values for the atomic weights deduced are very close to the best experimental numbers.

The elastic breakdown of materials submitted to compound stresses forms the subject of articles in *Engineering* of February 5 and 12, contributed by Mr. L. B. Turner. The author discusses the various theories and investigations which have been advanced for ductile materials, the three principal being Rankine's, based on breakdown taking place when a certain maximum tension occurs; Euler's, based on a certain maximum stretch being obtained; and Guest's, based on occurrence of a certain maximum shearing stress. Of these, the first two will not bear the test of experimental investigation; the latter was first enunciated by Guest in the *Philosophical Magazine*, 1900, and was supported by a large number of his experimental results. Mr. Turner has repeated some of Guest's experiments, using weldless steel tubes, which were all annealed under similar conditions in an electric furnace. Nineteen results for combined pull and torque are given, of which two may be disregarded as being abnormal. The remaining seventeen results show a mean difference of 485 lb. per square inch in the maximum shearing stress at breakdown, giving a discrepancy of 3 per cent. only. By calculation from the results of these tests, it is shown that the maximum tension hypothesis is wrong by 50 per cent., and the stretch hypothesis by 35 per cent., taking Poisson's ratio as 0·3. Mr. Turner's experiments may therefore be regarded as giving strong support to Guest's theory. The author proposes to investigate stress of three dimensions, and also to find how far the results obtained for static stress may be applied to the case of stress the magnitude of which is subject to constant variation.

THE twentieth annual issue—that for 1909—of the "Public Schools Year-book and Preparatory Schools Yearbook" is now available. Among new features characterising the present volume may be mentioned articles on the universities, giving full details of universities other than Oxford and Cambridge; additional information on qualifying for the Scots Bar and the profession of Writer to the Signet; an article dealing with chemistry as a profession; and a list of lecturers who attend public and preparatory schools. To parents and others selecting either a school or a profession for their boys this enterprising annual should prove invaluable; it is published by Messrs. Swan Sonnenschein and Co., Ltd., and its price is 3s. 6d. net.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MARCH:—

March 1. 11h. 32m. Neptune in conjunction with the Moon (Neptune 2° 37′ S.).
4. 12h. 37m. Variable star Algol at minimum.
5. 21h. 50m. Jupiter in conjunction with the Moon (Jupiter 3° 42′ S.).
7. 9h. 26m. Variable star Algol at minimum.
16. 3h. 3m. Mars in conjunction with the Moon (Mars 1° 26′ N.).
,, 14h. 19m. Uranus in conjunction with the Moon (Uranus 2° 4′ N.).
20. 13h. 0m. Venus in conjunction with the Moon (Venus 3° 52′ N.).
21. 23h. 46m. Saturn in conjunction with the Moon (Saturn 2° 41′ N.).
26. 8h. 54m. Mars and Uranus in conjunction (Mars 0° 18′ S.).
27. 11h. 8m. Algol at minimum.
28. 17h. 30m. Neptune in conjunction with the Moon (Neptune 2° 51′ S.).
30. 8h. 40m. Red spot central on disc of Jupiter.

A BRILLIANT METEOR AND ITS TRAIN.—A brilliant meteor was seen over a large part of the south of England about 7.30 on Monday evening, February 22. A luminous cloud or streak was visible for a long time after the meteor itself had disappeared. The Rev. F. J. Jervis-Smith, F.R.S., writing from Battramsley House, near Lymington (long. 1° 32′ W., lat. 50° 48′ N.), says:—"At 7.30 p.m. on February 22 my attention was directed by my gardener to a luminous streak or band left by a meteor, which he had seen about twenty minutes before while cycling near Brockenhurst. The streak was not straight, but slightly curved, first towards the north, then to the south, then again to the north, then, turning through about 110° to its mean path, towards the south, it was lost to sight. The streak passed through ε Ursæ Majoris and γ Cassiopeiæ. The streak was clearly visible up to 8 p.m. The width of the luminous band covered, roughly, one-eighth of the distance between δ and ζ Ursæ Majoris. The gardener described the luminous head of the meteor as being like the head and shoulders of a whale in shape. While I watched the streak a small meteor crossed the heavens, starting near Polaris, the path being south to north."

Miss Annie L. Waud, observing at Farnham, first observed the luminous appearance at 7.50 p.m. "It was then in Eridanus, and was a glowing streak of light, with two short branches or tails; the streak rapidly moved towards the north-west, the tails growing longer, the upper one gradually spreading through Orion, first through Rigel and then through the belt, finally stretching far beyond and above that constellation. The mass grew fainter as it sank at 8.30 p.m. towards the west, but the upper tail, which was now forked, was distinct until 9.30 p.m."

Dr. T. K. Rose saw this luminous train between Orion and the horizon, at Northwood, "from about 7.45 to between 9 and 10 o'clock, when it was lost in mist near the horizon. It was faint, and could not have been seen but for the brilliance of the night." The apparent shape of the luminous mass changed greatly during this interval, but no nucleus was seen by Dr. Rose at any time. With an opera-glass stars could be seen through the cloud.

QUANTITATIVE MEASURES OF THE WATER-VAPOUR IN THE MARTIAN ATMOSPHERE.—From measures of the relative intensities of the a, water-vapour, band in the spectra of Mars and the moon recently obtained by Mr. Slipher at the Lowell Observatory, Prof. Very has derived quantitative results showing the probable ratio between the amount of water-vapour in the Martian atmosphere and the amount of water-vapour in the Flagstaff atmosphere at the time the spectrograms were taken.

The measurements were made with a "spectral-band comparator" devised by Prof. Very, the narrower component of the a band, λ 7160–7200, being measured in every case; the relative intensity of the C band was also measured, on each set of spectra, as a check.

The readings given by the comparator were found to be very consistent, but were merely conventional. Reducing these measures so that they represent absolute intensities, Prof. Very finds that the a band in the spectrum of Mars is about 4·5 times as strong as in the lunar spectrum, and a further reduction brings out the fact that at the time of exposure the Martian atmosphere must have held in suspension about 1·75 times as much water-vapour as existed in the earth's atmosphere above Flagstaff.

Finally, Prof. Very arrives at the conclusion that whilst the atmosphere above Flagstaff contained sufficient precipitable water to give an average layer of about 8 mm. in depth, the average layer of precipitable water on Mars was about 14 mm.; the mean value for the earth would probably be three or four times as great (Lowell Observatory Bulletin, No. 36).

ABSORPTION OF LIGHT IN SPACE.—In a paper appearing in No. 1, vol. xxix., of the *Astrophysical Journal* (p. 46, January), Prof. Kapteyn discusses one or two phenomena which point to the absorption of star-light during its passage through interstellar space.

That the stars appear gradually to thin out as we recede farther and farther from the solar system is *a priori* evidence that some such absorption exists, otherwise we must assign to the sun a unique position in the universe, that is, the place of maximum density.

In a previous discussion Prof. Kapteyn found a provisional value for the absorption amounting to 0·016 of a magnitude for the distance of thirty-three light-years, as an average for the whole of the sky. Recently obtained results of spectral classification, from Harvard, permitted him to make another attack on the problem by investigating the probable average distances of Miss Maury's two classes of stars of which α Boötis and α Cassiopeiæ are typical. The spectra of the former of these two classes exhibit less general absorption than do those of the latter, and from an analysis of the proper motions given in Newcomb's "Fundamental Catalogue" Prof. Kapteyn finds that, *as a rule*, the proper motions in the α Boötis division greatly exceed those in the α Cassiopeiæ division. This is evidence that they are, as a class, nearer to us, and would, therefore, exhibit less general absorption, if it were due to an absorbing medium, than would the α Cassiopeiæ stars. Thus the present investigation strengthens the probability of the existence of such an absorbing medium.

THE ORBIT OF θ AQUILÆ.—From radial-velocity observations made at the Allegheny Observatory during 1907, Mr.

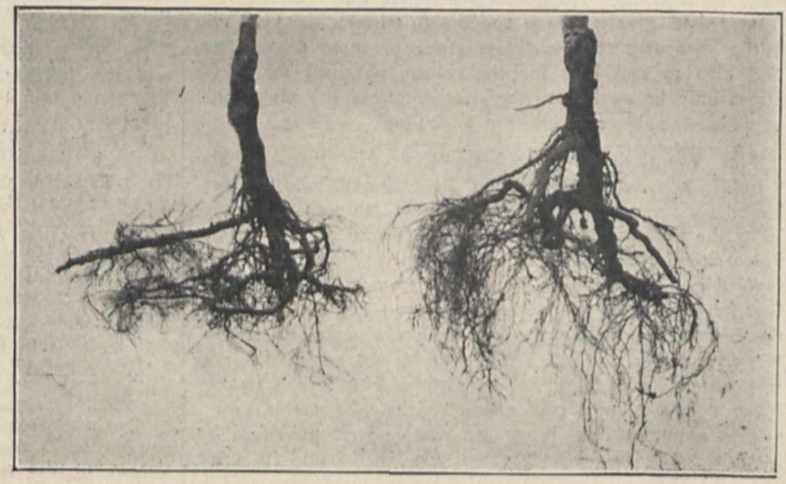
Baker has derived new elements for the orbit of θ Aquilæ, which he gives and discusses in No. 7, vol. i., of the Publications of the Allegheny Observatory. These elements show the eccentricity of the orbit to be $0{\cdot}685 \pm 0{\cdot}011$, and the period of the binary to be $17{\cdot}117 \pm 0{\cdot}0042$ days. From observations made in 1901–2, M. Deslandres found a period of 16·7 days, and Mr. Baker ascribes the difference to an actual change of the period; the eccentricity is also probably variable.

THE PLANTING OF FRUIT TREES.[1]

MR. PICKERING is playing no new part when, in the recently issued report of the Woburn Fruit Farm, he appears as the demolisher of cherished convictions concerning so fundamental and practical a matter as tree planting. It is an article of faith among fruit-growers that fruit trees must be planted in a certain special way if success is to be obtained. The soil is properly prepared, a large hole is made, wide, but not deep, the roots are carefully spread out in all directions and arranged near the surface, with a slight upward bearing at the ends. The soil is filled in with many precautions. Small quantities of the finer soil are first worked in among the roots, hollow places caused by archings in the stouter roots are filled up, and then the rest of the soil is put in, trodden carefully down, and the whole left to the compacting influence of the rain. The tree is supported by stakes until it is sufficiently firmly established.

All this, according to the report before us, is precisely wrong; it is all exactly the opposite of what it should be. The proper way to plant a tree is to make a small hole, to double the roots up anyhow and stick the tree in, throw in the soil, and ram it down as hard as if one were fixing a gate-post. The experiments seem convincing enough. They have been made at Woburn, Harpenden, Bedford, various places in Cambridgeshire, and in Devonshire; 59 per cent. of the sets showed in favour of ramming, 27 per cent. showed no difference (*i.e.* all the elaborate detail of the ordinary way of planting was simply a waste of time), and only 14 per cent. were against ramming. It makes no difference by what criterion the trees are judged; planting in this new way gives better results than planting in the orthodox fashion.

When a new fact is established by scientific experiment that no longer fits in with the old practical formula which has hitherto sufficed to cover all cases, there is invariably a cry raised about the antagonism of theory (or science) and practice. This has duly happened in the present case. But no practical man has been able to give any reason for the faith that is in him beyond the fact that it is sanctioned by established custom; these appear to be the first serious experiments on the subject, and they do not seem to be vitiated by any constant error. Examination of the trees shows that ramming has led to a copious development of fibrous roots; the photographs here reproduced give an idea, though not an adequate one, of this effect. Direct experiments showed that the fibrous and small roots produced in the nursery before lifting play no great part as roots during the subsequent life of the tree; the important point is to induce fresh root formation, and ramming does this more rapidly than the orthodox method of planting. No harm was done, and sometimes even good resulted, when the old roots were deliberately damaged before planting.



Not rammed. Rammed.
FIG. 2.—Marie Louise.

Not ammed. Rammed.
FIG. 1.—Gascoyne

It is to be hoped that these experiments may be continued on fruit soils of various types. Both the Harpenden and Ridgemont soils are heavier than the typical fruit soils of Kent; it would be interesting to see how ramming works on the brick earths, Thanet and Lower Greensand formations, where so much of our fruit is grown.

The reports issued from the Woburn Fruit Farm are always interesting, because they deal with fundamental problems of universal importance, and not merely with local matters. No fruit-grower could afford to make experiments himself on anything like the scale on which they are carried out at Woburn; and fruit-growers everywhere are under an obligation to the Duke of Bedford and Mr. Pickering for investigating their problems for them and publishing the results in so accessible a form.

E. J. RUSSELL.

[1] Ninth report of the Woburn Experimental Fruit Farm, by the Duke of Bedford, K.G., F.R.S., and Spencer U. Pickering, F.R.S.

POSITION OF THE METRIC SYSTEM.

IT may now be said that the metric system of weights and measures is preferred by every Government in the world outside the British Empire, and that in this advance there has been no retreat.

Its opponents say that though foreign Governments may prefer the reform, it is fairly practised only in a few countries. The truth about this alleged discrepancy between law and popular usage is to be found in two parliamentary papers (Cd. 258 of 1900 and Cd. 435 of 1901), also partly in the records (Paris: Gauthier-Villars, 1907) of the last International Metric Conference, where England had two representatives.

Let us consider, first, the nations which have made least progress. The United States of America have not gone far—far enough, nevertheless, to decide their future, for there is no record of a reverse either in public opinion or practice, except, perhaps, in Turkey, where the Government applied violent coercion to an ignorant populace. Many public Acts of the United States show that their method of progress is to accustom, first their officers and then the public, to the new system before applying it to commerce. Accordingly, it has been introduced with great ease and success into the medical services of the army, navy and public health. There was no trouble, even in the difficulties of war with Spain, when civilian physicians, accustomed only to the old system, were enrolled for service. In some American cities medical prescriptions are by choice almost all metric. Electrical quantities, and to some extent electrical machinery, are metrically described, and metric standards, furnished by the International Bureau at Paris, are alone legal as the ultimate tests of American units. The United States have maintained the metric system in Cuba, Porto Rico, and the Philippines. Russia established it with complete success for all purposes in Finland sixteen years ago, and for the medical services of the Imperial Army and Navy last year. In 1907 it was reported at the International Conference to be spreading "rapidly and without opposition" throughout the Empire under the special direction of Privy Councillor M. Egoroff.

The Chinese Empire may be quoted, like other Governments, as committed to the metric system. After consideration, it has during the past year decided to alter the chief linear unit (chih) to 32 centimetres, as a step towards metric reform, and this was done in face of a petition from 100 British merchants in favour of a British unit.

Japan, also, has recently given effective approval to the metric system by legalising it, teaching it in the primary schools, and using it for the medical services of the army and navy, also for scientific work. At the Paris conference of 1907 "legislation for its definite adoption" was announced to be in preparation. Meanwhile, tens of thousands of metric standards were being issued by the Government. British units are also used for engineering and for imported machinery.

On and after April 1 of next year taxes and customs dues in Denmark will be based on the metric system. The system will become general and obligatory on April 1, 1912.

It is thus seen that these five Powers, the slowest to move, have approved, but do not yet largely practise, the metric system. The rest of the world, outside the British Empire, both approves and practises, excepting Turkey, Greece, some of the smaller South American republics, and various savage regions.

Notwithstanding what has been said above, some anti-metricists declare that even in France the system is largely discarded. The answer to this is that old names are sometimes applied to metric units, *e.g.* the half-kilo. is sometimes called the livre, just as we call twenty-one shillings a guinea, and, secondly, textile goods of English sizes and marks go largely into foreign countries, and are even made there, just as motor-cars and electric machinery of metric size are found in England. There is no sign of metric failure in this, because in a metric country everything is sold metrically.

Even within the British Empire the self-governing colonies are eager for the reform. Australasia and New Zealand have twice urged it upon England, and New Zealand has recently legislated for the purpose. South Africa has suggested it, and the Canadian Government has employed a lecturer to popularise it.

In presence of the above-stated facts, there is obvious danger that England may soon be isolated even from her English-speaking kinsfolk in the matter of weights and measures, notwithstanding the vain suggestion of an Anglo-Saxon conference to improve the British system and retain it in concert with America. There is India, of course, on which we could force any system, wise or foolish, for chaos rules there, and the situation is tolerated partly because full-weight silver coins serve as standard weights, and liquids are generally weighed. The kilogram was legalised for official use and railways on the advice of General Sir R. Strachey in 1871, and the death of Lord Mayo alone prevented its introduction. India deserves better treatment, for it is to her that we owe, through the Arabs, not only the ten numeral figures, but probably also the device whereby both the form and position of each fix its meaning.

The cost and trouble of change are the chief real objections, so it is of the highest importance to remember that metricists do not propose to force the reform into factories, industries, or private life, but only into buying and selling. Cloth, yarn, ironwork, and everything could be made of any size or weight, but in the market such size or weight, if stated, would have to be in metric figures. There would be no alteration of count, number, pattern, or mark under which cloth, yarn, screws, &c., are often sold. In private life the glass of beer, the teaspoonful of medicine, &c., would remain.

Shopkeepers and merchants, probably also railways, would be compelled to use new weights and yard sticks, and their example would quickly educate the whole country. No more than this limited compulsion was proposed to Parliament in 1907, but objectors presented estimates of cost based on universal compulsion, and the result was an adverse vote of 150 against 118. The House of Commons had not then before it the evidence afterwards given at the Paris International Conference, that commerce can be metric without impeding industry.

There is, however, a considerable class of people who can never be converted except perhaps by fear of international isolation. Therefore, pending another attempt at legislation, the converted should practise their faith rather than preach it to the deaf. Scientific societies and scientific departments of State could favour metric usage, as the British Medical Association is now doing, and as the Government might do in the medical services of its army, navy, and public health, unless it distrusts the American experience above stated.

In meteorology, geology, and cartography there is much room for advance, excepting the excellent maps with scales of 1/2500 and 1/5000.

There is not space here for the long array of great names which support this reform, and it ought to be needless to state that the system does not embrace angles, time, navigation, thermometry, money, or anything but measures of length, surface, volume, and weight. Nevertheless, it may be mentioned that one of its principles, the counting by tens, which abolishes compound arithmetic, would save here, as in all foreign countries, a vast total of human energy, especially in application to money. It is estimated that in the Custom House alone decimalised money would save 20,000*l*. a year.

BIRD-LIFE.

THE feeding-habits of the dunlin form the subject of a paper—based on close personal observation—contributed by Mr. J. M. Dewar to the January number of the *Zoologist*. In surface-feeding these attractive birds search for small organisms floating in the wash of the sea or carried seawards by the shore-streams, as well as for minute insects and spiders on the sand or mud, although the main objects of their quest are tiny univalve molluscs, with the shells of which their gizzards are always crammed. Dead shells, which form a large proportion of those on most shores, are left alone. Dunlins also probe the sand or mud for bivalve molluscs and worms. Both in the act of tapping and probing the two halves of the beak appear to be slightly separated; it is also probable that the separation increases with the depth of the probing, although the upper and lower portions remain nearly parallel until they are thrust in to their extreme limit, when the terminal part of the upper one becomes expanded at the moment of contact with the "find."

The already overcrowded list of so-called British birds has been increased by the capture, on Fair Isle in September, 1908, of a specimen of Eversmann's warbler (*Phylloscopus borealis*). This bird, which is really a dark-coloured willow-wren, has been recorded once in Heligoland, in 1854, but its normal summer haunts are Finmark, northern Russia, and Siberia, while in winter it wanders to Burma, Malaya, and China. Fuller details of the capture will be found in the January number of Witherby's *British Birds*.

Captain Stanley Flower and his assistant, Mr. M. J. Nicoll, have drawn up a list of the species of wild birds which have been observed to visit the zoological gardens at Giza during the period between October, 1898, and October, 1908. This list, which has been published by the Egyptian Government, comprises no less than 166 species, eleven of which are, however, not indigenous to the country, and were accordingly, in all probability, represented by imported individuals. The very large number, both as regards species and individuals, which visit the establishment adds considerably to the attractions of the Giza Gardens, and the list has been published in response to inquiries from visitors as to their names. It is a prevalent idea that song-birds are lacking in Egypt, but a visit to the gardens when the nightingale and the rufous and olive warblers are singing will at once dispel this illusion.

In the report of the vertebrate section of the Yorkshire Naturalists' Union for 1908 reference is made to the appearance of a flock of Pallas's sandgrouse on the northern slope of the wolds during the autumn of that year. The great grebes on Hornsea Mere have been reduced to three, and it is believed that the diminution is mainly to be attributed to egg-collectors and other visitors. The peregrine falcons again built on Bempton Cliffs, where they reared a single young one.

The birds of the Barotsi district of the Zambesi form the subject of a paper by Mr. A. Sandberg in vol. vii., part ii., of the Proceedings of the Rhodesia Scientific Association. As an illustration of the teeming bird-life of the great valley, the author writes that "the traveller encounters enormous numbers of geese, ducks, and wading birds in wonderful variety of species, size, and coloration, and the sand-banks of the river, upon which they find a refuge, present an appearance at times which can best be described as kaleidoscopic. Above the almost deafening din of their shrill voices can be distinguished the incessant cry of the fish-eagle, for ever on the alert for prey."

PREHISTORIC ARGENTINA.[1]

THE pottery described in the first of the papers mentioned below was mainly obtained in the province of Catamarca. The specimens are illustrated by handsome coloured plates drawn from photographs. The earliest type includes bowls and jars, ornamented in white, red, and black in imitation of the woven patterns of basket-work. Similar ornamentation is found in the baskets, cloth, and pottery of New Mexico and California. Another type, with red and black colouring, shows either geometrical designs or outlines of animals, especially frogs and snakes, usually conventional in character. Among the objects depicted are the anura, *Ceratophys ornata* and *Leptodactylus ocellatus*, and the ophidia *Elaps frontalis* and *Lachesis alternatus*, as well as the rhea and puma and a fern, a species of Hymenophyllum. There are also crude representations of human beings.

The second article describes two human faces in terra-cotta, and part of the head of an animal supposed to be the coyote (*Canis cagottis*), in the same material. These were found in a high bank in the Laguna de Lobos, in the province of Buenos Aires. They are so closely similar to the earthenware "masks" found in such numbers in the ancient ruins at San Juan de Teotihuacan, in Mexico, that the author believes that they were manufactured there, but he declines to advance any theory to explain their presence in the Argentine.

The third paper deals with implements and fragments of pottery collected by Señor Carlos Ameghino on the site of a prehistoric settlement in the extreme south of the province of Buenos Aires, and distant 5 kilometres from the sea-shore. They were found on the surface at the foot of unconsolidated sand-dunes, and include flakes, scrapers, chisels, knives, arrow-heads, and grinding stones, all primitive in character. These appear to have been manufactured from ellipsoidal beach-stones, mainly jasper, though phonolite, chert, porphyritic breccia, and other materials were also employed. The grinding stones are of hard grit ("asperón").

The pottery was moulded of a sandy clay, and imperfectly baked. It was ornamented with grooves and pits made with the nail or a fragment of wood.

The collection indicates, we are told, a culture similar to that which still characterises the middle and lower parts of the basin of the Rio Negro, certain localities in the government of the Pampa, and the southern plains of the province of Mendoza. It presents many points of resemblance to that met with in the southern part of the government of the Rio Negro and in the governments of the Chubut and Santa Cruz, but differs completely from that of the rivers Salado, San Borombón and Luján, and generally the eastern portion of the province of Buenos Aires.

J. W. E.

[1] (1) Alfarerías del Noroeste Argentinto (Anales del Museo de La Plata, series ii., vol. i.). Pp. 5 to 40.
(2) Sobre el Hallazgo de Alfarerías Mexicanas en la Provincia de Buenos Aires (Revista del Museo de La Plata, vol. xv., series ii., vol. ii.). Pp. 284 to 293.
(3) Arqueología de San Blas (Anales del Museo Nacional de Buenos Aires, vol. xvi. (series iii., vol. ix.). Pp. 249 to 275. All by Señor F. Outes.

THE INCREASED EXPANSION OF STEAM ATTAINABLE IN STEAM TURBINES.[1]

I FIND it difficult to add anything to the words of the many illustrious men who have addressed this society on previous anniversaries of the birth of James Watt, to the words of Sir Humphry Davy, Lord Aberdeen, and Lord Jeffrey, and in later years to those of Joule, Scott-Russell, Preece, and Kelvin. This evening I should prefer to recall to your memories the fundamental principles of steam discovered by James Watt, and to endeavour to trace their application in the engines constructed by him and by the firm of Bolton and Watt, then in the more highly developed forms of compound, triple, and quadruple reciprocating engines, and, lastly, in steam turbines on land and sea.

The laws of steam which James Watt discovered are simply these, that the latent heat is nearly constant for different pressures within the ranges used in steam engines, and that, consequently, the greater the steam pressure and the greater the range of expansion the greater will be the work obtained from a given amount of steam, and, secondly, as may be seen to us now as obvious, that steam from its expansive force will rush into a vacuum.

Having regard to the state of knowledge at the time, his conclusions appear to have been the result of close and patient reasoning by a mind endowed with extraordinary powers of insight into physical questions, and with the faculty of drawing sound practical conclusions from numerous experiments devised to throw light on the subject under investigation. His resource, courage, and devotion were extraordinary, and drew to his side a coterie of kindred spirits, with whom he discussed freely his theories and his hopes, and the results of his experiments.

In commencing his investigations on the steam engine, he soon discovered that there was a tremendous loss in the Newcomen engine which he thought might be remedied—the loss caused by condensation of the steam on the cold metal walls of the cylinder. He first commenced by lining the walls with wood, a material of low thermal conductivity. Though this improved matters, he was not satisfied; his intuition doubtless told him that there should

[1] The James Watt lecture delivered at Greenock by the Hon. C. A. Parsons, F.R.S.

be some better solution of the problem, and doubtless he made many experiments before he realised the true solution in a condenser separate from the cylinder of the engine. It is easy after discovery to say how obvious and how simple, but many of us here know how difficult is any step of advance when shrouded by unknown surroundings, and I can well appreciate the courage and the amount of investigation necessary before James Watt thought himself justified in trying the separate condenser.

But to us now, and to the youngest student who knows the laws of steam as formulated by Carnot, Joule, and Kelvin, the separate condenser is the obvious means of constructing an economical condensing engine.

Watt's experiments led him to a clear view of the great importance of securing as much expansion as possible in his engines. The materials and appliances for boiler construction were at that time so undeveloped that steam pressures were practically limited to a few pounds above atmospheric pressure. The cylinders and pistons of his engines were not constructed with the facility and accuracy with which we are now accustomed, and chiefly for these reasons expansion ratios of from two- to three-fold were the usual practice. Watt had given to the world an engine which consumed from five to seven pounds of coal per horse-power hour, or one-quarter of the fuel previously used by any engine. With this consumption of fuel its field under the conditions prevailing at the time was practically unlimited. What need was there, therefore, for commercial reasons, to endeavour still further to improve the engine at the risk of encountering fresh difficulties and greater commercial embarrassments? The course was rather for him and his partners to devote all their energy to extend the adoption of the engine as it stood, and this they did; and to the Watt engine consuming from five to seven pounds of coal per horse-power mankind owes the greatest permanent advances in material welfare recorded in history.

The Watt engine, with secondary modifications, was the prime mover in most general use for eighty years until the middle of the last century, when the compound engine began to be introduced. Why, we may inquire, was it that the compound engine was so long in coming into use, for it had been patented by Hornblower in 1781, or seventy years before? and why does John Bourne in his large book, "Practical Instructions for the Manufacture and Management of every Species of Engine," published 1872, make no mention in the index of the compound or triple expansions, and when he speaks of Hornblower's double-cylinder engine (really a compound engine) does he do so in disparaging terms, mentioning that there was no increased economy in steam over the single cylinder? This last statement provides an answer to our inquiry, for it is correct in view of the very low steam pressure in general use before that time, or until somewhat before the middle of the last century, when the introduction of the locomotive led to a general rise in pressures on land, and the surface condenser some years later to increased steam pressure at sea. Also, we must remember that many experiments have shown that unless the mean difference of pressure on a piston exceeds about 7 lb. per sq. inch, the friction, the bulk, the momentum of the moving parts, and the cost make such a cylinder not worth having. The case, however, with the turbine is entirely different, and it is chiefly owing to this difference and to its power of usefully expanding the steam down to the very lowest vapour pressure attainable in the best condenser that it has surpassed the best reciprocating engines in economy of steam. To return to our subject. The introduction of the compound, triple, and quadruple expansion engines was therefore concurrent with the improvements in boiler construction, the introduction of the surface condenser, and the general rise in steam pressure, and by the quadruple engine the expansion ratio has been extended up to about sixteen-fold, and the consumption of coal per horse-power reduced to from $1\frac{1}{4}$ lb. to $1\frac{1}{2}$ lb. per horse-power hour, or to from one-fourth to one-third the fuel consumed in the time of James Watt. Let us now direct our attention to the turbine engine, which derives its power, not from the pressure of the steam on a piston, but from the momentum of the steam at high velocity curving around and blowing forward the vanes or paddles attached to the shaft.

It is unnecessary here to recapitulate the many attempts to construct a successful steam turbine from the days of Hero until a quarter of a century ago, as several excellent books are now published on the subject. It is true that the difficulties of construction and inferior workmanship available during this early period were a serious bar to progress, but the chief bar to progress lay in the fact that the turbine, to be economical in steam, must (at least in its primitive form) rotate at a very high speed, and that before 1880 there was no commercial use for such a high-speed engine excepting through the intermediary of belts or friction gearing, or for such exceptional purposes as the direct driving of circular saws. The chief purpose for which turbines are now extensively used on land did not then exist, namely, for the driving of dynamos. Then, again, belts for high speeds are a very unsatisfactory appliance, and accurately cut spiral gearing as recently introduced by Dr. de Laval had not been devised; and, again, the problem of applying a turbine to the propulsion of vessels being surrounded, as it was, with great consequential difficulties would naturally only be attacked after the successful application of the prime mover to some easier and simpler purpose on land, so that I think, on the whole, we may safely say that under the conditions prevailing the commercial introduction of the turbine before 1880 was a practical impossibility.

It is a matter of history that the turbine principle had been used for obtaining power from waterfalls before the days of James Watt, but I am not clear that he had in mind any concrete form of steam turbine; yet in 1770 he suggested "a circular engine consisting of a right-handed and left-handed bottle-screw spiral involved in one another," and he also appears to have had a leaning towards some form of directly rotary engine, for in 1769 he took a patent for a Barker's reaction water-wheel, the water pressure being derived from the action of steam on water, as in Savery's fire-engine or a modern pulsometer. He also designed a rotary abutment engine in 1782, but in none of these machines is there any indication of an attempt to gain greater expansion ratios for the steam.

It is peculiarly interesting to recall on this occasion that one of the earliest steam turbines to be put to practical work was in this town; it was about the middle of the last century, and was a turbine like that described by Branca in 1629. It consisted of a steam jet playing upon a paddle-wheel, coupled to a circular saw, which it drove for some years. The principle of the expansive working of steam was, however, only to a small extent utilised in this engine, for I believe that the steam jet was non-divergent, which implies a useful expansion ratio of only about $1\frac{1}{2}$-fold. One of the most conspicuous workers in the design of the compound turbine was Robert Wilson, of Greenock, Master of Arts of Edinburgh, who lodged a patent in 1848. This patent was of unusual length and wealth of detail, and describes radial-flow and parallel-flow compound turbines, designed for moderate ratios of expansion. The blades and guides were proposed to be fastened by casting them into the hub and case, a method occasionally used at the present time.

The principles of Wilson's design are generally correct, but the proportions of his turbines are extravagantly incorrect, the blades being too large and too few for success. I had a model made of Wilson's turbine eighteen years ago, and under steam all that could be said was that it went round the right way. I do not think that Wilson can have made a model and tested it before he applied for his patent, the course followed by James Watt, and one which is to be strongly recommended to the attention of inventors generally in almost all circumstances, as saving time, money, and disappointment. There have been many workers on steam turbines of English nationality before and since the time of Wilson, but within the last twenty years other countries have taken up the subject with zest.

Prior to 1880 the uses for a very high-speed motor were few, as we have seen; the speed of revolution of steam wheels, as Bourne described them in 1872, "was inconveniently high for most purposes," but after 1880 conditions were changed; the beautiful machine, the milk separator, of Dr. de Laval, of Stockholm, and the great invention of the dynamo electric machine had come, and required a high-speed prime mover to drive them, and these provided encouragement to the workers on steam turbines; thus between 1884 and 1888 we find the practical and successful realisation in altered and correct proportions of ideas and suggestions of previous workers, the compound steam turbine in 1884 applied to the direct driving of dynamos, and the single-stage impulse wheel in 1888, of very high velocity, played upon by the expanding steam jet, both types possessing great ratios of expansion.

All steam turbines now in practical use expand the steam usefully over nearly the whole range from the boiler pressure to the pressure in the condenser, and their designs are based on the principles involved in the construction of their prototypes of 1884 and 1888.

There is, first, the compound turbine, the characteristic feature of which is the gradual expansion of the steam by small drops of pressure at each turbine of a long series of turbines of gradually increasing volumetric capacity, as in the Parsons, or a somewhat less gradual expansion with greater drops of pressure at each stage, as in the Rateau, Zoelly, and others.

Then there is the expansion by the divergent jet in one stage, as in the de Laval, or an expansion in a relatively small number of stages by expanding jets playing upon rows of buckets with intermediate rows of reaction guides, as in the Curtis and Reidler-Stumpf.

Then there are combinations of the first and second, where the first stage of the expansion is affected by, say, a Curtis element, and the rest by a Parsons, and many other combinations have also been proposed, too numerous to mention here.

Let us consider these principal examples of the turbine principle more closely. In the compound turbine the velocities of the steam are low; at each passage through the blades it expands a little, yet it obeys, as regards the velocity of efflux, approximately the laws of flow of fluids; but the aggregate of the small expansions soon becomes apparent, and has to be taken into account when reckoned over a considerable number of the series of elemental turbines. For instance, if the expansion ratio for a single turbine of the series be as 1 to 1·03 in volume, a 3 per cent. expansion, then after passing through twenty-three turbines its volume will be doubled, and the velocity of flow through the guide blades and moving blades (presuming they are of equal area of passage way) will be about 230 feet per second. The velocity of the blades is, generally speaking, about half the velocity of the steam at issue, and will therefore, in this case (which I have taken as common in marine practice), be about 115 feet per second.

The difference in velocity of the steam and the blades is smoothed over largely by the curvature of the blade, which somewhat resembles a shallow hook around which the stream lines in the steam arrange themselves with very little shock or eddying in the steam, so that the coefficient of efficiency is high.

In turbines for driving dynamos and other purposes where higher speeds of revolution are permissible, steam velocities up to 600 feet and blade velocities up to 300 feet per second at the exhaust ends are general.

In turbines of the Rateau, Zoelly, and other types with multiple discs, each disc carries one row of blades only, and works in a cell, through the walls of which the shaft passes in a steam-packed gland; nearly the whole drop in pressure takes place at the guide vanes, and very little at the moving vanes, which are of cup form; the velocities of the steam generally range from 900 feet to 1100 feet per second, and the velocities of the blades from 350 feet to 450 feet per second. In turbines, however, of the de Laval single-wheel and of the Curtis and other types with a relatively small number of pressure stages, higher steam velocities are used, ranging from 4200 feet per second in the single-wheel down to 1500 feet in a seven-stage Curtis turbine. The jets used in the single-stage turbine are of very divergent form, but when the expansion is divided over seven stages very little divergence is necessary.

In the single-stage turbine, blade velocities so high as 1200 feet per second are adopted, the discs being of taper form and of the strongest nickel-steel; but even this high velocity is insufficient to obtain a very good coefficient of efficiency from the steam, and when the disc is made large, so as to reduce the immense angular velocity incidental to the high peripheral speed, the skin friction of the disc and the prime cost and weight increase rapidly.

In the Curtis five-stage the blade velocities are about 460 feet per second, and the steam velocity about 2000 feet per second, and by the passage of the steam through two rows of moving and one row of guide blades between them at each wheel the steam is brought nearly to rest before passing on to the next succeeding chamber, and by this sinuous treatment of the steam efficiencies are obtained comparable to those of the compound turbine.

From the commencement of turbine design in 1884 I have avoided the adoption of high steam velocities on account of their cutting action on metals when any water is present. The cutting has been found to be due, not to the impact of gaseous steam, but to that of minute drops of water entrained by the steam, and hurled by it against the surfaces. The drops, formed like fog, consequent on the expansion of saturated steam, are sufficiently large to cause the erosion. To test the effect in an extreme case, a hard file was placed opposite to a jet of steam issuing at 100-lb. pressure into a vacuum of 1 lb. absolute pressure; in 145 hours it was found to be eroded to the extent of about 1/32 inch, as if it had been sand-blasted. The calculated velocity of the issuing steam in this case is about 3800 feet per second, and the striking fluid pressure of a drop of pure water at this velocity about ninety tons per square inch. Owing, however, to the receding velocity of the blades from the blast in all turbines, the erosive effect is much reduced. In multicellular turbines of few stages, though the erosion is slow, yet provision is necessary for renewal of blades at intervals. In turbines of many stages it is still slower, and in the compound turbine erosion is, practically speaking, absent, and renewal of blades unnecessary. This absence of the tendency to erosion in compound turbines permits the use of brass or copper blades, which are found to preserve their polish and are not liable to corrosion or rusting, and preserve their smoothness of surface and the initial economy of the engine unimpaired for many years.

It is now just fifteen years ago, and exactly ten years from the commencement of work on the compound steam turbine, that the results obtained on land were thought to justify an attempt to apply the turbine principle to the propulsion of vessels. These results lay in the fact that a condensing turbine engine of 200 horse-power, with an expansion ratio of 90 volumes, had been found to have equal economy to a good compound piston engine, and that, besides, there were within sight reasons to hope for still better results. A commencement was made, and by the end of 1897, after three years of hard work and experiment, the *Turbinia* was completed. Her trials were usually made on the measured mile in the North Sea, but occasionally, when the sea was too rough, runs at speeds up to 31 knots were made on the Tyne, where the legal limit of speed of steamships was 7 knots, and by the magnanimity of the Tyne Improvement Commissioners the completion of the *Turbinia* was greatly facilitated, though it is fair to say great care was exercised and no harm done to the public. In her the problem of adapting the turbine to the screw propeller was worked out. The result was a compromise between the two. The turbine had to be made short and broad, so as to revolve as slowly as possible, and the screw had to be made with finer pitch and wider blades. The result in propulsive efficiency was found to be good, and the problem satisfactorily solved for fast vessels of 16 knots and upwards, and it was also seen that the faster the vessel the more favourable would be the economy of the turbine as compared with the reciprocating engine.

The destroyers *Viper* and *Cobra* followed. The next step was the application of the turbine to vessels of commerce.

Dumbarton was the scene of many conferences. Mr. Archibald Denny was deeply interested in the problem, and so was Captain John Williamson, with the result that the first passenger vessel, the *King Edward*, was built in 1901 at Dumbarton to the joint ownership of Captain John Williamson, Messrs. Denny, and the Parsons Marine

Steam Turbine Co., Ltd. The success of this vessel soon led to the adoption of turbines in cross-Channel steamers, and also led, aided by the success of the destroyers *Viper* and *Velox*, to the specification of turbines in H.M.S. third-class cruiser *Amethyst*, and from that time turbines began to be rapidly adopted for fast vessels, including the largest and fastest mercantile and war vessels afloat.

The success of the *King Edward* in 1901 was a red-letter day for the marine turbine. Let us inquire in what this success consisted. In the first place, a factor of primary importance is the coal bill, and it was soon proved by Messrs. Denny that this was less to the extent of from 15 per cent. to 25 per cent. than with vessels propelled by reciprocating engines of equal displacement and carrying capacity. Also the cost of oil, which with reciprocating engines amounts to about 5 per cent. of the coal bill, was nearly eliminated; the vibration was also less. Then the upkeep of machinery was found to be favourable, and as the crew became accustomed to her the coal consumption still further diminished, and I am informed by Captain Williamson that this further decrease has been well maintained up to the present time. The exceptional trustworthiness of the machinery also became more and more assured.

There are now about 120 vessels actually on service fitted with turbines, and seventy more under construction, representing a total horse-power of marine turbine engines of about 2,250,000, of which 1,250,000 horse-power is completed.

There were two other great steps in the adoption of the turbine, which occurred almost simultaneously in 1905, namely, the decision of the Admiralty to adopt turbines for all new construction in fighting ships, and the adoption of turbine machinery for the great Cunarders. The steps from the second-class cruiser *Amethyst*, of 15,000 horse-power, to the *Dreadnought*, of 22,000 horse-power, and to the *Indomitable*, of 41,000 horse-power, were, it is true, gradual, but the number of vessels involved was great. In the mercantile marine the step from the *Queen*, the first cross-Channel vessel, of 8000 horse-power, directly to the *Lusitania* and *Mauretania*, of 70,000 horse-power, required great courage on the part of the late Lord Inverclyde and his co-directors and engineers. Such steps as these are not taken without thorough investigation based on ascertained results. When it is considered that the low-pressure turbine in the *Queen* was 6 feet in diameter, 20 feet in length, and 25 tons in weight, as compared with the Cunarders' low-pressure turbines of about 17 feet 6 inches diameter, 50 feet in length, and 300 tons weight, it is realised what a great departure was involved; forces and conditions were altered; differential expansions and deflections of the structure had all to be re-considered in detail, for though they had been successfully dealt with and controlled in the smaller engine, the magnitude of the larger structure rendered re-calculations and thorough investigation necessary; thus no room was left for the possibility of any adverse conditions arising, due to the very great increase in the size of structure, and everything that care, thought, and experience could accomplish was done, and the results have satisfactorily agreed with the hopes and estimates of all concerned.

In the *King Edward* there was a great increase in the ratio of expansion beyond that hitherto realised in any reciprocating engine. Her boiler pressure is 150 lb., and the pressure at the inlet to the turbines at normal full speed 130 lb.; the pressure in the condenser is 1½ lb. absolute, a ratio of 87 by pressure or about 66 by volume, as compared with the volumetric ratio of about 10 in triple-expansion reciprocating engines for a similar class of vessel.

In some later turbine vessels higher steam pressures have been adopted, resulting in a small gain in efficiency, partly counterbalanced by the greater weight of the turbine cases, and if the vessel has Scotch boilers, then also by the greater weight of the boilers to carry the greater pressure; and on the whole the net gain, if any, is but small.

A substantial increase in efficiency has, however, been realised by improvements in condensers and pumps, in order to take full advantage of the property of the turbine of expanding steam usefully to the lowest pressure attainable in the condenser. Before the turbine came into use a very high vacuum was not found desirable, for the simple reason that the reciprocating engine is unable to utilise it. For instance, a triple-expansion engine does not gain in economy of coal if the absolute pressure in the condenser be diminished below 2½ lb. The turbine, however, derives a net gain in efficiency of 13 per cent. from a diminution of pressure in the condenser from 2½ lb. absolute to 1 lb. absolute.

The improvements that have been introduced of late years in condensing plants consist primarily in improved design of the condenser and in improvements in air pumps to increase their volumetric capacity. In the condenser the tubes are so spaced and grouped that the steam, attenuated into relatively an enormous volume, shall pass freely without much resistance and drop of pressure throughout the whole surface, and provision is made by the form of the condenser shell, with or without a single baffle plate, so that the suction of the air pump shall remove the air uniformly from all parts. The vacuum now usually obtained in well-equipped turbine vessels is very close to that corresponding to the temperature of the circulating water leaving the condenser. The difference is sometimes so small as two degrees, so that there is no room for much further improvement in this direction. To increase the volumetric capacity of the air pumps, dry air pumps run at a high speed may be used, separate pumps being employed to remove the water of condensation. An alternative, and perhaps a preferable method, is the vacuum augmenter, a simple apparatus without moving machinery, which consists of a very small steam jet placed in a narrowed portion of the ordinary air-pump suction, which sucks the air out of the condenser and compresses it through a small intermediate cooler into the suction of the air pump, the water of condensation draining by gravity through a water seal into the same air-pump suction.

Further possible improvements would therefore seem to tend in the direction of an increase in the efficiency of the turbine itself. In large turbine vessels the ratio of the shaft horse-power to the total available energy in the steam from boiler to condenser reaches 70 per cent., and the question is whether there is a probability of somewhat reducing this loss of 30 per cent.

During the last eleven years a small reduction in steam per horse-power delivered to the shaft has been brought about by minor improvements in design, better finish and proportion of the blading, and by the increased size of the engine constructed.

In 1897 the *Turbinia* consumed 16 lb. per shaft horse-power for all purposes; in 1901 the *King Edward* consumed 16 lb. per shaft horse-power for all purposes; in 1907 the *Lusitania* consumed 12 lb. per shaft horse-power for all purposes; and the *Mauretania* consumed 11·5 lb. per shaft horse-power for all purposes.

In the case of slow vessels, where the exigencies of the screw propeller limit the revolutions to a low rate, I have for many years advocated a combination or partnership between the reciprocating engine and the turbine which seemed to promise a high degree of efficiency and to suit all the requirements of the case. In this combination each engine deals with that part of the expansion for which it is best suited, the reciprocating engine taking the high-pressure portion from the boiler pressure down to about atmospheric pressure, and the turbine carrying on the expansion from about atmospheric pressure right down to the condenser pressure.

The reciprocating engine is thus relieved of the low-pressure part of the expansion, which at best it carries out in a very inefficient manner, losing as it does all the last part, and the turbine is relieved from the high-pressure part, which when constructed for slow revolutions it performs unsatisfactorily; but the turbine designed for low pressures and slow revolutions is an engine which converts a very high percentage of the power in the steam into shaft horse-power.

Messrs. Denny have fitted the *Otaki*, of 8000 tons, 5000 horse-power, and 13 knots sea speed, with this system, the boiler pressure being 200 lb., no superheaters being fitted, and the very low consumption of 12·3 lb. of steam for all purposes was registered on trial. Messrs. Harland and Wolff are also fitting a vessel for the Dominion Line on this system.

James Watt, we are told, suggested the screw propeller in 1770; half a century later it commenced to come into use, and now it is almost universally adopted in all new construction.

It is a very interesting and curious fact to note that in the first instance, and for many years, the screw was driven by spur gearing from a very slow-speed engine, presumably because the builders of engines were afraid to design the engines to run so fast as the screw required to be driven. Now for forty years or more gearing has been entirely abandoned, and the high-speed reciprocating engine has worked well.

The turbine has now come on the scene, and its best speed of revolutions is faster than that of the screw, excepting in fast vessels; for the larger portion of the tonnage of the world it is at present unsuited, except to take a secondary but excellent part in the combination system.

We may naturally speculate as to the future, and inquire if there is a possibility of the turbine being constructed to run more slowly and without loss of economy, or whether the propeller can be modified to allow of higher speed of revolution.

Or, again, may a solution be found in reverting to some description of gearing, not to the primitive wooden spur gearing of half a century ago, but to steel gearing cut by modern machinery with extreme accuracy and running in an oil bath, helical tooth gearing or chain gearing, or, again, some form of electrical or hydraulic gearing?

These are questions which are receiving attention in some quarters at the present time, and if a satisfactory solution can be found, then the field of the turbine at sea will be further extended.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE.

CAMBRIDGE.—It is proposed to confer the honorary degree of Sc.D. on Dr. Sven Hedin on Thursday, March 4. Dr. Sven Hedin will lecture before the Senate on that date in the Senate House. Before the ceremony he will be entertained at lunch by the master and fellows of Gonville and Caius College.

The Isaac Newton studentship, tenable from April 15, 1909, to April 15, 1812, has been awarded to Mr. W. J. Harrison, of Clare College.

The Lowndean professor, Sir Robert Ball, F.R.S., will lecture on "Ancient and Modern Views of the Constitution of the Milky Way" before the Cambridge Antiquarian Society on Monday, March 1, at 4.30 p.m.

In July of last year letters signed by the Chancellor were sent to more than 300 universities, colleges, academies, and other corporate bodies, inviting them to appoint delegates to attend the Darwin celebration from June 22–24 next. In answer to these invitations more than 200 delegates have been appointed. The expense likely to be incurred in carrying out the programme amounts to considerably more than 500*l.*, but it is hoped that it may be possible to provide the excess above that sum by private subscriptions, and the Senate will therefore not be asked to authorise the expenditure of more than 500*l.* from the University chest.

MR. E. C. WILLS has given 10,000*l.* to the Bristol University Fund, thus raising the fund to practically 200,000*l.*

WE learn from a recent number of *Science* that Mrs. E. G. Hood has given the University of Pennsylvania 20,000*l.* to establish graduate fellowships in the law department. Mr. Adolphus Busch, who last August promised to contribute 10,000*l.* towards the 60,000*l.* necessary for the erection of the new building for the Germanic Museum at Harvard University, has increased his gift to 20,000*l.* The General Education Board has offered to give Bryn Mawr College 50,000*l.* on condition that friends of the college subscribe 56,000*l.* by June, 1910. This is in addition to the 20,000*l.* recently given by the alumnæ. Of this sum, 26,000*l.* is to be used to pay the debt of the college, and the balance is to be reserved as an endowment fund.

A ROYAL COMMISSION has been appointed to consider the position and organisation of university education in London. The terms of the reference to the commission are:—to inquire into the working of the present organisation of the University of London, and into other facilities for advanced education (general, professional, and technical) existing in London for persons of either sex above secondary-school age; to consider what provision should exist in the metropolis for university teaching and research; to make recommendations as to the relations which should in consequence subsist between the University of London, its incorporated colleges, the Imperial College of Science and Technology, the other schools of the University, and the various public institutions and bodies concerned; and further to recommend as to any changes of constitution and organisation which appear desirable. In considering these matters, regard should also be had to the facilities for education and research which the metropolis should afford for specialist and advanced students in connection with the provision existing in other parts of the United Kingdom and of His Majesty's dominions beyond the seas. The chairman of the commission is Mr. R. B. Haldane, K.C., M.P., and the other members are Viscount Milner, G.C.B., G.C.M.G., Sir Robert Romer, G.C.B., Sir R. L. Morant, K.C.B., Mr. Laurence Currie, Dr. W. S. M'Cormick, Mr. E. B. Sargant, and Mrs. Creighton. The joint secretaries are Mr. J. Kemp and Dr. H. F. Heath.

SOCIETIES AND ACADEMIES.

LONDON.

Royal Society, January 28.—Mr. A B. Kempe, treasurer, in the chair.—The action of the venom of *Sepedon haemachates* of South Africa: Sir T. R. **Fraser** and Dr. J. A. **Gunn.**—The colours and pigments of flowers, with special reference to genetics: Miss M. **Wheldale.** The communication gives an account of investigations made upon plant pigments, with a view to the elucidation of phenomena observed in the genetics of flower-colour. A primary classification is made into plastid pigments and pigments soluble in the cell-sap. Of the former, several kinds are shown to exist, in addition to carotin and xanthin. When the type of a species contains more than one plastid pigment, the power to produce each pigment is expressible as a Mendelian factor. Loss of the factors in turn gives rise to varieties of the type. Soluble pigments are classified as red-purple-blue (anthocyanin) and yellow (xanthein) and of both; various kinds can be differentiated by means of chemical reagents. There is evidence, moreover, of a relationship between the behaviour of the pigments in genetics and their chemical reactions. Colourless tannin or glucoside-like substances are found to be widely distributed in plants, and such substances appear to take part in the formation of some kinds of anthocyanin. This conclusion is based upon examination of pigments of varieties of *Antirrhinum majus*, of which the inheritance of flower-colour has been worked out by the author (previous communication to Roy. Soc.); the results of the present paper show that in this genus both a glucoside-like substance and a reddening factor are essential to the production of anthocyanin of the type. Loss of glucoside gives rise to an albino variety still capable of carrying the reddening factor; loss of the reddening factor gives a variety bearing ivory-white flowers, distinguishable from the albino, and containing the glucoside. Experiments on the same genus further indicate that the xantheïc pigment of a yellow variety is a derivative of the glucoside of the ivory-white, to which it is also hypostatic. Examples are given of genera resembling Antirrhinum in their series of varieties derived from the anthocyanic type, and also of genera forming another series, from which the xantheïc variety is absent. In this connection, stress is laid upon the conception of two forms of albinism, one due to loss of anthocyanin only, the other to loss of both anthocyanin and xantheïn.—The variations in the pressure and composition of the blood in cholera, and their bearing on the success of hypertonic saline transfusion in its treatment: Prof. L. **Rogers.** This communication contains some points of interest in physiology, pathology, and therapeutics. The blood of Bengalis has been found by Captain Mackay to contain a higher proportion of salts and a less proportion of red blood corpuscles than the blood of Europeans. The author has found that the blood pressure in the natives is lower than in Europeans, averaging about 100 millimetres of mercury. The pathological observations are that in cholera the enormous secretion of fluid into the bowel drains away the fluid part of the blood. There is a very definite relationship between the amount of fluid thus lost from the blood and the severity and mortality of the disease. Injections of normal saline solution (0·65 per cent. of NaCl) into the veins have an almost miraculous effect in relieving the symptoms and restoring the patient to apparent health. This improvement is, however, only transient, and in the course of a few hours the symptoms recur and the patients die. It occurred to the author that if, instead of using a normal saline solution, he were to inject a hypertonic solution of 1·35 per cent. NaCl into the veins, there would be less likelihood of the diarrhœa recurring, and the blood being again drained of its fluid parts. The result of this treatment was extraordinary. It has simply revolutionised the results, so that, whereas formerly the recovery of a collapsed case was a surprise, its non-recovery is now a disappointment. In severe cases the proportion of chlorides in the blood falls below the normal, notwithstanding the great concentration of the blood from loss of water. He therefore sometimes uses a saline solution of 1·65 per cent., but usually 1·35 per cent. is sufficient. In bad cases the coagulability of the blood is very greatly reduced, so that the author now generally adds 3 gr. of calcium chloride to a pint of saline solution. The development of uræmia in the reaction stage of cholera is associated with a comparatively low blood-pressure; measures to raise it, such as the hypodermic administration of adrenalin and digitalis, are indicated for the prevention and treatment of this very serious complication.—The British fresh-water phytoplankton, with special reference to the desmid-plankton and the distribution of British desmids: W. **West** and G. S. **West.** The paper is in part a comprehensive summary of the known facts concerning the phytoplankton of British fresh waters. It has been possible to institute a close comparison between the British phytoplankton and that of continental Europe, proving that the British lakes are relatively richer in green algæ and poorer in blue-green forms than the generality of continental lakes. The large percentage of green species in the British lakes is due, in most instances, to the dominance of desmids. Certain diatoms also stand out conspicuously, especially some of the large species of the Surirellaceæ. As the plankton investigations were not commenced until the authors had acquired a very extensive knowledge of the general British alga-flora, it has been a comparatively easy matter to see wherein the phytoplankton differs from the algæ of the littoral region and of the bogs, &c. An extended study of the distribution of British desmids has shown that the rich desmid areas correspond (1) to a considerable extent with the areas of greatest rainfall, and (2) to a much closer extent with the outcrops of the older Palæozoic and pre-Cambrian strata. The really rich desmid-floras only occur in those western and north-western districts in which the geological formations are older than the Carboniferous, and these are likewise the districts in which the British lakes are situated. Therefore, the dominance of desmids in the phytoplankton is not so remarkable as might at first be supposed. Numerous desmids are continually washed from the drainage-areas into the limnetic region of the lakes, and some of them have become leading constituents of the phytoplankton, either with or without change of morphological characters. Many of them form a well-marked assemblage, the individual constituents of which are limited in their British distribution to the western lake-areas, although most of them occur in the lakes and bogs of Scandinavia on precisely similar outcrops of old rocks. It is suggested that perhaps the most important factor in this relationship is a chemical one, but, so far as observations have been made, ordinary chemical analysis of the drainage-waters has offered no clue to the solution of the problem.—The selective permeability of the coverings of the seeds of *Hordeum vulgare*: Prof. Adrian J. **Brown.** It has been pointed out previously ("Annals of Botany," 1907, vol. xxi., p. 79) that the coverings of the seeds of barley act as an exceptionally perfect semi-permeable membrane, resisting the passage of acids, of alkalies, and of salts, but not of iodine. Experiments are now described from which it appears that not only strong electrolytes, but also dextrose, cane sugar, and other non-electrolytes are unable to penetrate the membrane. On the other hand, mercuric chloride and cyanide, but neither the nitrate nor sulphate, cadmium iodide, but not the chloride nor the sulphate, ammonia, acetic acid and several of its homologues, alcohol and ethylic acetate, are all capable of passing into the corns. Glycollic and lactic acids also pass in, but far less rapidly than acetic. The water-absorbing capacity of the seeds when immersed in various solutions has been contrasted with that of the seeds when placed in water alone. Far less water is absorbed from solutions of substances which do not penetrate the seed covering than from those containing substances which do. In the case of substances which diffuse readily into the corn, such as ammonia and ethylic acetate, the rate at which water passes in is much more rapid than from solutions of substances which do not penetrate the covering, or from water alone.—The origin of osmotic effects, ii., differential septa: Prof. H. E. **Armstrong.** It is shown that the effects described by Prof. Brown may be explained in terms of the theory of the conditions of substances in solution recently communicated to the society by the author. Substances such as ammonia, acetic acid, &c., which exist in solution in a slightly *hydrolated* state, would pass the hydrolated surfaces of the intramolecular passages in the colloid membrane, whilst hydrolated solutes would be held back. The increased rapidity with which water enters in some cases is traceable to the effect which the diffusing substance has in raising the osmotic stress in the water within the corn.

February 4.—Sir Archibald Geikie, K.C.B., president, in the chair.—The electricity of rain and its origin in thunderstorms: Dr. G. C. **Simpson.** During 1907–8, an investigation was undertaken at the Meteorological Office of the Government of India, Simla, into the electrical phenomena which accompany rain and thunderstorms, with results which have led to the following theory. It is exceedingly probable that in all thunderstorms ascending currents greater than 8 metres a second occur. Such currents are the source of large amounts of water, which cannot fall through the ascending air. Hence, at the top of the current, where the vertical velocity is reduced on account of the lateral motion of the air, there will be an accumulation of water. This water will be in the form of drops, which are continually going through the process of growing from small drops into drops large enough to be broken. Every time a drop breaks, a separation of electricity takes place, the water receives a positive charge, and the air a corresponding amount of negative ions. The air carries away the negative ions, but leaves the positively charged water behind. A given mass of water may be broken up many times before it falls, and, in consequence, may obtain a high positive charge. When this water finally reaches the ground, it is recognised as positively charged rain. The ions which travel along with the air are rapidly absorbed by the cloud particles, and in time the cloud itself may become highly charged with negative electricity. Now within a highly electrified cloud there must be rapid combination of the water drops, and from it considerable rain will fall; this rain will be negatively charged. A rough quantitative analysis shows that the order of magnitude of the electrical separation which accompanies the breaking of a drop is sufficient to account for the electrical effects observed in the most violent thunderstorms. All the results of the observations of the electricity of rain described in the paper are capable of explanation by the theory, which also agrees well with the actual meteorological phenomena observed during thunderstorms.—The effect of pressure upon arc spectra, No. 3, silver, λ 4000–λ 4600: Dr. W. G. **Duffield.** This paper is the third that the author has presented to the Royal Society upon the effect of pressure upon arc spectra. The behaviour of the iron, copper, and silver arc spectra (region λλ 4000–4600) has now been described, the former under pressures up to 100 and the last two up to 200 atmospheres. In course of time the author hopes to publish the results of investigations upon the spectrum of gold, iron, and nickel under pressures up to 200 atmospheres, and of other regions of the copper and silver spectrum up to the same pressure. Photographs of all these have been obtained.—The tension of metallic films deposited by electrolysis: G. G. **Stoney.** It is well known that metallic films deposited electrolytically are in many cases liable to peel off if deposited to any considerable thickness, especially in the case of nickel, which, if deposited above a certain thickness, curls up into beautiful close rolls in cases where the film does not adhere closely to the body on which it is deposited. The late Earl of Rosse, F.R.S., also found it impossible to produce flat mirrors electrolytically on account of the "contraction" of the coat of copper, and the author has observed similar phenomena in protecting the silver film of searchlight reflectors when the thickness of the copper coat was above 0·01 mm. Dr. Gore, F.R.S., and others have observed similar phenomena. These phenomena would be explained if the metal were deposited from the solution under tension, and it was found that when a thin steel rule was coated on one side with nickel it became bent, even to the extent of 3 mm. or 4 mm. in 100 mm. This bending could not be caused by any difference of expansion between nickel and steel, as the whole was immersed in the depositing solution, and this was at a constant temperature. From the thickness of the rule, the amount of nickel deposited, and the bending, the tension under which the film was deposited was calculated, and found to amount to 2840 kilos. per square cm., or 18·1 tons per square inch. It was also found that this tension was independent of the temperature and strength of the solution, as well as the current density, so long as the deposit was a good dense one. When the rules were heated to a red heat to anneal them, the deflection was reduced to from one-third to one-half the original.—A further note on the conversion of diamond into coke in high vacuum by kathode rays: A. A. Campbell **Swinton.** In a previous paper on this subject by the Hon. Charles A. Parsons and the writer (Proc. Roy. Soc., A, vol. lxxx., pp. 184–5), experiments were described designed to ascertain whether any gas was emitted by diamond during its conversion into coke. The present note has reference to further and more detailed investigation, made on the suggestion of Mr. Parsons by the writer, with special regard to the possibility of diamonds containing neon, krypton, or other rare gas which would be emitted on the diamond being converted into coke. As before, spectrum tubes connected with the kathode-ray furnace were sealed off so as to contain samples of the residual gas before and after the conversion. The spectra of these were compared both photographically and also by direct visual examination in the spectroscope, with the result that, though differences were observed in regard to the relative brightness of various individual lines in the two spectra, careful observation showed that in no single instance was there any line in one spectrum that could not be obtained in the other by suitably adjusting the strength of the electric discharge through the spectrum tube. From this it would appear that the conversion of diamond into coke, if it sets free any gas at all, at any rate does not liberate any other than one or more of the comparatively common gases that are generally found as residuals in kathode-ray tubes exhausted from air in the ordinary way. Though this is a negative result, it has been thought well to put it on record.

Geological Society, February 10.—Prof. W. J. Sollas, F.R.S., president, in the chair.—Note on some geological features observable at the Carpalla china-clay pit in the parish of St. Stephen's (Cornwall): J. H. **Collins.** An east-and-west fault traverses this pit near its southern wall, with a downthrow to the south of more than 50 feet. North of the fault there is china-clay rock or "carclazyte," at one point underlying granite not sufficiently altered to yield china-clay, and sometimes containing embedded lenticles or irregular masses of partly kaolinised granite. South of the fault there is nearly horizontal tourmaline-schist. Underlying the schist there occurs also china-clay rock to a distance of many fathoms from the fault. This occurrence of china-clay under a thick schistose overburden is unique in Cornwall. It is maintained that this example is in favour of the pneumatolytic origin of carclazyte, the gases producing the change being possibly in part carbonic acid, but probably to a more important degree chlorine, fluorine, and boron.—Some recent observations on the Brighton cliff-formation: E. A. **Martin.** Features presented by the face of the cliffs between successive falls at Black Rock, Brighton, during the past eighteen years are recorded. As the cliffs have worn back, the base-platform of Chalk grows in height, and the layer of sand above the Chalk grows thinner and thinner, until it disappears. The raised beach has grown in thickness from 1½ feet to 12 feet. In 1890 there were 6 feet of sand, with a foot and a half of beach above it. In 1892 the sand had decreased to between 3 feet and 4 feet, but the beach remained as in 1890. Many falls of cliff took place between 1892 and 1895, and at the latter date the beach had increased to between 4 feet and 5 feet. The eastern limit of the beds had become more clearly defined. In 1897 10 feet of chalk formed the lower portion of the cliff, with 8 feet of raised beach above it in places, but there was a mere trace of sand left. In 1899 the raised beach had reached a thickness of 10 feet. Great masses of moved and reconstructed chalk were observed on the eastern boundary embedded in the beach. In 1903 the beach was but a little more than 8 feet thick in the exposed parts, but the platform of Chalk was 14 feet thick. In 1906 the raised beach had increased from 15 feet to 20 feet; farther west, however, the thickness was not so great. In 1908 there were 17 feet of Chalk, 12 feet of beach. If the material is to be prevented from disappearing into deep water, some such contrivance as chain-cable groynes seems to be demanded, fixed somewhere between low and high tide-marks.

Physical Society, February 12.—Dr. C. Chree, F.R.S., president, in the chair.—Annual general meeting.—Presidential address: Dr. **Chree.** An account was given of some work the president had recently been engaged in, in connection with the reduction of the magnetic observations of the National Antarctic Expedition of 1902–4. This referred to an inter-comparison of simultaneous records of magnetic disturbances obtained in the Antarctic and at the observatories of Kew, Falmouth, Colaba (Bombay), Mauritius, and Christchurch (New Zealand). He exhibited a number of lantern-slides showing the sudden commencement of some magnetic storms, and the forms of some special types of disturbance observed in the Antarctic. Some results were given as to the directions and intensities of the disturbing forces to which the disturbances recorded at the different stations might be attributed.

Royal Meteorological Society, February 17.—Mr. H. Mellish, president, in the chair.—Report on the phenological observations for 1908: E. **Mawley.** The most noteworthy features of the weather of the phenological year ending November, 1908, were the severe frosts early in January, the exceptionally heavy fall of snow and remarkably low temperatures in the latter part of April, and the marked periods of unusually wet and dry weather during the summer. In February and March wild plants came into blossom in advance of their usual time, but throughout the rest of the flowering season were more or less behind their average dates. Such early spring migrants as the swallow, cuckoo, and nightingale made their appearance very late. The only deficient farm crop was that of barley. The yield of wheat, oats, and beans was rather above the average, that of peas and hay very good, while the crops of turnips, mangolds, and potatoes, taken together, were the most abundant for many years.—The cold spell at the end of December, 1908: W. **Marriott.** The most remarkable feature was the intense cold which prevailed over the central and south-eastern portion of England on December 28–31. At several places the lowest temperature recorded was about zero. For the month of December the cold was very exceptional, as the only instances in the neighbourhood of London or at Greenwich in which the maximum temperature was below 25°·5 for the day were the following:—1796, 25, 19°·5; 1798, 28, 19°·5; 1816, 22, 24°·0; 1830, 24, 22°·0; 1855, 21, 23°·2; 1874, 31, 24°·5; 1890, 22, 23°·7; and 1908, 29, 25°·4, and 30, 23°·3.

CAMBRIDGE.

Philosophical Society, January 25.—Sir J. J. Thomson, vice-president, in the chair.—A string electrometer: T. H. **Laby**. An electrometer consisting of a stretched silvered quartz-fibre between two charged plates was shown. Tested on steady potentials it had the following properties:—(1) The sensitiveness for a constant fibre tension increased rapidly with increasing potential difference between the plates. (2) With the plates at 6·7 mm. apart and charged to +10 volts and −10 volts the sensitiveness was more than 70 eye-piece divisions per volt. (3) The deflection of the fibre is proportional to its potential. (4) When not very sensitive it may be used as an oscillograph. Further work is being done on this application of it.—The secondary Röntgen radiation from air and ethyl bromide: J. A. **Crowther**. The amounts of secondary Röntgen radiation from air and ethyl bromide have been compared, using ethyl bromide as the absorbing gas. The results in the main confirm those previously obtained with air as the absorbing medium. Corrected results for the relative amounts of secondary radiation from these gases are given.—Interference fringes with feeble light: G. I. **Taylor**. Interference photographs were taken with light of such small intensity that single exposures extended over several months. The fact that they were well defined was taken to indicate an upper limit to the magnitude of the indivisible unit of energy occurring in the non-homogeneous wave-front theory of light.—The solution of linear differential equations by means of definite integrals: H. **Bateman**.

February 8.—Mr. S. Ruhemann, vice-president, in the chair.—Further studies on dihydroxymaleic acid: Dr. **Fenton** and W. A. R. **Wilks**. The authors are continuing the investigation of the properties and transformations of dihydroxymaleic and dihydroxytartaric acids, and in the present communication a brief account is given of some recent results.—Homologues of furfural: Dr. **Fenton** and F. **Robinson**. New syntheses have been effected by the application of the Friedel and Crafts reaction to the halogen derivatives of methylfurfural with various hydrocarbons, and the results promise a wide field for further investigation.—Action of urethane on esters of organic acids and mustard oils: S. **Ruhemann** and J. G. **Priestley**. The sodium-derivative of ethyl carbamate reacts with ethyl phenylpropiolate, not by addition, but with formation of ethyl phenylpropiolylcarbamate. Similarly, the esters of fatty saturated acids furnish acid derivatives of ethyl carbamate. Phenyl mustard oil reacts with ethyl sodiocarbamate, and yields the anhydride of diphenylthiobiuretcarboxylic acid. Besides this compound, a small quantity of carboxyethylphenylthiocarbamide is formed. Analogous is the action of ethyl sodiocarbamate on other mustard oils.—The absorption spectra of solid tetramethyl picene and of its solutions: Annie **Homer** and J. E. **Purvis**. The absorption bands of a very thin film of the hydrocarbon were compared with those when the substance was in solution in benzene and in alcohol. The results showed that the three bands were identical in each case, but that there was a shift of both the bands and the general absorption towards the red end of the spectrum, according to the density of the medium. The bands of the solid were shifted towards the red end of the spectrum more than those of the benzene solution, and those of the benzene solution more than in the alcoholic solution. The vapour of the substance was also examined, and it showed a beautiful blue fluorescence, but it decomposed so rapidly that no observations could be made as to its fluorescent spectrum.—The absorption spectra of mesitylene and trichloromesitylene: J. E. **Purvis**. The absorption spectra of N/1000 alcoholic solutions were compared, and the absorption curves were drawn from the numbers obtained. It was found that there was a shift of the bands of the trichloromesitylene towards the red end of the spectrum when compared with those of mesitylene. The strong band of mesitylene, λ 275–λ 245, was shifted in the trichloromesitylene to λ 287–λ 263, and, besides that, the persistence of the absorption curve of the latter was considerably increased.—The absorption spectra of concentrated and diluted solutions of chlorophyll: J. E. **Purvis**. The ratio of the dilutions was 1/719, and the diluted solution was placed in a tube 719 times larger than that containing the strong solution. The light, therefore, passed through the same amount of chlorophyll. The two solutions showed exactly the same phenomena at the commencement of the observations. The bands at λ 538 and λ 565 were equally well marked, and the general absorption was the same. After standing some hours, the diluted solutions showed changes in the appearance of the bands; λ 538 became more diffuse, and λ 538 and λ 565 appeared to diffuse into each other, whilst a band at λ 508 appeared, and the general absorption was almost the same as at the commencement. The change continued very slowly for several days. The final result showed that in the strong solution the band λ 538 was as well marked as at the beginning, and that the band λ 508, which appeared after some hours, remained the same, and the band λ 565 appeared to be the same as at the beginning. On the other hand, the general absorption had lessened very considerably as compared with the dilute solution. These changes are ascribed to the action of enzymes, probably oxydases.—A coloured thio-oxalate: H. O. **Jones** and H. S. **Tasker**. Diphenyldithio-oxalate is readily prepared by the action of oxalyl chloride on thiophenol, and crystallises in beautiful bright yellow prisms melting at 119°–120°. The compound is the first dithio-oxalate known, and it is interesting in that it is coloured, while oxalates are colourless. It appears to distil unchanged, decomposes into thiophenol and potassium oxalate when boiled with caustic potash, and gives off carbon monoxide when treated with sodium or sulphuric acid.—Note on some double fluorides of sodium: W. A. R. **Wilks**. Cryolite, a double fluoride of sodium and aluminium, has already been prepared synthetically. The author shows that by carrying out the precipitation in a different way another double fluoride is obtained, which is so insoluble that it may be used as a test for sodium.

PARIS.

Academy of Sciences, February 15.—M. Émile Picard in the chair.—The construction of orthogonal systems which comprise a family of Dupin cyclids: Gaston **Darboux**.—The tectonic of the Palæozoic strata at the north-west and north of Sablé (Sarthe): D. P. **Œhlert**.—M. Jungfleisch was elected a member in the section of chemistry in the place of the late A. Ditte.—Observations of the comet 1908*c* (Morehouse), made at the Observatory of Athens with the Gautier 40-cm. equatorial: D. **Eginitis**. Four sets of observations, made on November 28, December 1, 3, and 4, 1908, are given for this comet, together with the apparent positions of the comet and mean positions of the comparison stars.—Selective effect in the ionisation of a gas by an alternating field: Henry A. **Perkins**.—The melting point of platinum: C. **Féry** and C. **Chéneveau**. The Féry absorption pyrometer used in these experiments, the indications of which, based on Wien's law, are only accurate for a black body, was calibrated against a Le Chatelier couple. The platinum was fused in two ways, by passing an electric current through a wire placed in a horizontal and a vertical position, and by heating in a suitable gas burner. The melting points obtained varied from 1690° C. to 1750° C. The variations in the melting point appear to be related to the nature of the gas in which the fusion is produced.—The reversal of the green radiation produced by the mercury arc in a vacuum: A. **Perot**.—The influence of the extreme regions of the spectrum in phenomena of solarisation: A. Gargam **de Moncetz**.—The compressibility of gases between 0 and 3 atmospheres and at all temperatures: A. **Leduc**. A re-calculation for twenty gases of the constants required for determining their molecular volumes at 0° C. and 100° C.—The thermal phenomena accompanying the action of water on aluminium powder: E. **Kohn-Abrest** and J. **Carvallo**. Water acts on aluminium with evolution of heat (about 1700 calories per gram) at a temperature of about 83° C.—The magnetic properties of some easily liquefiable gases: P. **Pascal**. The values of the specific magnetic susceptibility are given for eight gases in the liquid state, and, on the assumption that the specific susceptibility is independent of its physical state, the values for this constant for the same gases at 0° and 760 mm. pressure are calculated.—The catalytic oxidation of hypophosphorous acid by copper: J. **Bougault**. Precipitated copper exerts a catalytic action on hypophosphites, hydrogen being given off; one gram-molecule of copper was found to produce 30 gram-molecules of hydrogen in this way.—An exception to the general method of preparation of aldehydes by means of the glycidic acids: René **Pointet.** The general method indicated by Darzens does not give the expected diphenylacetic aldehyde, the glycidic ester splitting up into diphenylacetic acid and carbon monoxide instead of into carbon dioxide and the corresponding aldehyde.—Some halogen derivatives of γ-oxycrotonic acid: MM. **Lespieau** and **Viguier.**—Theory of the colour reactions of dioxyacetone in sulphuric acid solution: G. **Denigès.** Methylglyoxal, in sulphuric acid solution, gives the same colour reactions with alkaloids as dioxyacetone, and it is probable that the latter is converted into methylglyoxal in these reactions by the acid.—The oxidation of alcohols by the simultaneous action of tannate of iron and solution of hydrogen peroxide: E. **de Stœcklin.** Methyl, ethyl, normal propyl, and normal butyl alcohols are oxidised to aldehydes by hydrogen peroxide in presence of tannate of iron, as also are the alcohols glycol, glycerol, and sorbitol. Capryl, isopropyl, and isobutyl alcohols resist this oxidation.—Castration in *Zea mays*, var. *tunicata*, produced by *Ustilago maydis*: M. **Chifflot.**—Variations in grafted vines: F. **Baco.**—The influence of grafting on some annual plants, and plants living by their rhizomes: Lucien **Daniel.** Details of experiments, spreading over thirteen years, on the grafting of the potato on the tomato, and of Helianthus provided with rhizomes (*H. tuberosus, lactiflorus,* and *multiflorus*) on an annual (*H. annuus*).—The phytogeographical divisions of Algeria: G. **Lapil.**—The anatomical distinction of the genera Lithothamnion and Lithophyllum: Mme. Paul **Lemoine.**—A case of abnormal multiple cephalisation in Syllidians in stolonisation: Aug. **Michel.**—A special method of electrodiagnosis: M. **Guyenot.** An application of the instantaneous discharge of a condenser through an induction coil without an iron core to the quantitative study of the electrical stimulation of nerves. It has proved of practical service in the detection of cases of feigned paralysis.—Prehistoric rock engraving discovered at Île-d'Yeu (Vendée): Marcel **Baudouin.**—Seismic movements of February 9, 1909: Alfred **Angot.**—The solution of ferruginous dust of cosmic origin in the sea: M. **Thoulet.**

DIARY OF SOCIETIES.

THURSDAY, FEBRUARY 25.

ROYAL SOCIETY, at 4.30.—The Statistical Form of the Curve of Oscillation for the Radiation emitted by a Black Body: Prof. H. A. Wilson, F.R.S.—The Flight of a Rifled Projectile in Air: Prof. J. B. Henderson.—On the Cross-breeding of Two Races of the Moth *Acidalia virgularia*: L. B. Prout and A. Bacot.

ROYAL INSTITUTION, at 3.—Problems of Geographical Distribution in Mexico: Dr. Hans Gadow, F.R.S.

ROYAL SOCIETY OF ARTS, at 4.30.—The Bhuddist and Hindu Architecture of India: Prof. A. A. Macdonell.

INSTITUTION OF ELECTRICAL ENGINEERS, at 8.—*Further discussion*: The Use of Large Gas Engines for Generating Power: L. Andrews and R. Porter.

FRIDAY, FEBRUARY 26.

ROYAL INSTITUTION, at 9.—Osmotic Phenomena, and their Modern Physical Interpretation: Prof. H. L. Callendar, F.R.S.

PHYSICAL SOCIETY (at Finsbury Technical College, Leonard Street, City Road, E.C.), at 5.—A Laboratory Machine for applying Bending and Twisting Moments simultaneously: Prof. Coker.—On the Self-demagnetising Factor of Bar Magnets: Prof. Silvanus P. Thompson, F.R.S., and E. W. Moss.—Exhibition of Optical Properties of Combinations of Mica and Selenite Films (after Reusch and others) in Convergent Polarised Light: Prof. Silvanus P. Thompson, F.R.S.—Exhibition of Apparatus: C. R. Darling.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Standardisation in Engineering Practice: Dr. W. C. Unwin, F.R.S.

SATURDAY, FEBRUARY 27.

ROYAL INSTITUTION, at 3.—Properties of Matter: Sir J. J. Thomson, F.R.S.

MONDAY, MARCH 1.

SOCIETY OF CHEMICAL INDUSTRY, at 8.—On some Requirements of a Colour Standard: J. W. Lovibond.—Sulphur as a Cause of Corrosion in Steel: G. N. Huntly.

ROYAL SOCIETY OF ARTS, at 8.—Modern Methods of Artificial Illumination: Leon Gaster.

TUESDAY, MARCH 2.

ROYAL INSTITUTION, at 3.—The Evolution of the Brain as an Organ of the Mind: Prof. F. W. Mott, F.R.S.

ZOOLOGICAL SOCIETY, at 8.30.—The Development of the Sub-divisions of the Pleuro-peritoneal Cavity in Birds, illustrated by Lantern-slides: Miss Margaret Poole.—The Growth of the Shell of *Patella vulgata*, L.: E. S. Russell.—The Life-history of the Agrionid Dragon-fly: F. Balfour-Browne.—Growth-stages in the British Species of the Coral Genus Parasmilia: W. D. Lang.

INSTITUTION OF CIVIL ENGINEERS, at 8.—Some recent Grain-handling and Storing Appliances at the Millwall Docks: M. Mowat.

FARADAY SOCIETY, at 8.—On the Rate of Evolution of Gases from Homogeneous Liquids: V. H. Veley, F.R.S., and Dr. J. C. Cain.—The Electro-analysis of Mercury Compounds with a Gold Kathode: Dr. F. Mollwo Perkin.—The Relation between Composition and Conductivity in Solutions of *meta-* and *ortho-*Phosphoric Acids: Dr. E. B. R. Prideaux.

WEDNESDAY, MARCH 3.

SOCIETY OF PUBLIC ANALYSTS, at 8.—The Composition of Cider: B. T. P. Barker and E. Russell.—The Composition and Analysis of Chocolate: N. P. Booth, C. H. Cribb, and P. A. Ellis Richards.—Note on the Determination of Petroleum in Turpentine: J. H. Coste.

ENTOMOLOGICAL SOCIETY, at 8.—Birds as a Factor in the Production of Mimicry among Butterflies: Guy A. K. Marshall.

THURSDAY, MARCH 4.

ROYAL SOCIETY, at 4.30.—*Probable Papers*: On the Presence of Hæmagglutinins, Hæm-opsonins, and Hæmolysins in the Blood obtained from Infectious and Non-infectious Diseases in Man (Second Report): L. S. Dudgeon.—The Action on Glucoside by Bacteria of the Acid-fast Group, with a New Method of isolating Human Tubercle Bacilli directly from Tuberculous Material contaminated with other Micro-organisms (Preliminary Note): F. W. Twort.—The Effect of Heat upon the Electrical State of Living Tissues: Dr. A. D. Waller, F.R.S.

ROYAL INSTITUTION, at 3.—Problems of Geographical Distribution in Mexico: Dr. Hans Gadow, F.R.S.

RÖNTGEN SOCIETY, at 8.15.—Some Vacuum Tube Phenomena: A. A. Campbell Swinton.

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